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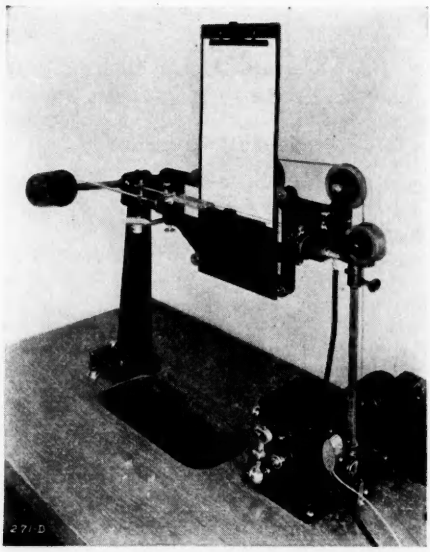

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The Textile Foundation, Inc.

Warp Sizing Research Conference

ENCOURAGED by the results of the open conference on the warp sizing of spun rayon, which was held Saturday, April 20, at State College Textile School, Raleigh, N. C., the Administrative Committee for this study has decided to start active research work, with Mr. F. Gordon Cobb as research associate, just as soon as a few remaining details of the program are decided and a miniature slasher for experimental work is delivered.

The conference was called by Carl R. Harris, manufacturing engineer, Erwin Cotton Mills Co., chairman of the Administrative Committee for the research, to complete the program and to enable non-subscribing mills and supply companies to learn at first hand of the plans and objectives. Although many of the present subscribers were unable to be present there was a registered attendance of 49, and this was increased by some 25 textile students.

Dean Thomas Nelson, who is a member of the Administrative Committee, was prevented by sickness from attending, and Albert H. Grimshaw, professor of textile chemistry and dyeing, substituted for him in an address of welcome at the morning session. Chairman Harris presided at both morning and afternoon sessions. The speakers at the morning session were W. D. Appel, chairman of the Institute's Research Council and Chief, Textile Section, National Bureau of Standards, who explained the purpose of the meeting, described the Institute's co-operative research method and its value to co-operators, and gave an outline history of the warp sizing program to date. Mr. Cobb presented a list of questions for discussion at the afternoon session which were supplementary to the tentative research program.

Following luncheon at the college cafeteria there was a tour of inspection, under the guidance of Prof. Grimshaw, of the rooms of the new Textile School building that will be available for this research work, and of the photographic, microscopic and other testing equipment, and the new slasher and weave room. The afternoon session was opened with a formal address of welcome on behalf of North Carolina State College by Colonel J. W. Harrelson, Dean of Administration. The discussion was then led by Dr. W. E. Yelland and Mr. Harold M. Chase. Both are members of the Administrative Committee, Dr. Yelland having been director of the Institute's completed warp sizing study, now being with the Research Laboratory of Corn Products Refining Co., and Mr. Chase being chief chemist, Riverside

and Dan River Cotton Mills. Both speakers outlined the various factors to be studied as given in the tentative program. While no changes were suggested in the discussion that followed, it was indicated by the interest shown in spun acetate and blends of that fibre with cotton and wool that the program should be expanded to cover those fibres. The afternoon session adjourned at 4.30 P. M. The revised program resulting from this conference will be submitted to subscribers for further suggestions, and it is hoped that these replies and final plans will be completed in time to start work not later than the first of June.

* * *

Personal

Arthur Besse, a director of the Institute, was re-elected president of the National Association of Wool Manufacturers at the 75th anniversary meeting of the organization.

* * *

Earl Constantine, a director of the Institute, was re-elected president of the National Association of Hosiery Manufacturers at the latter's annual meeting in Philadelphia last month.

* * *

Fessenden S. Blanchard, a director of the Institute and chairman of its Committee on Economic Research, was the guest speaker at the April meeting of the Northern New England Section of the A. A. T. C. C. at Andover (Mass.) Country Club, his subject being "The Consumer Movement in Textile Sales."

* * *

Dr. Edward W. France, who has resigned as head of the Philadelphia Textile School, was presented with an honorary certificate of membership in the group of textile school deans, sponsored by The Textile Foundation, at their meeting in Washington, D. C., the week of April 15.

* * *

Franklin W. Hobbs, chairman of The Textile Foundation, and other officers were re-elected at the annual meeting in Washington, D. C., April 17. Fredk. M. Feiker, dean of the School of Engineering, George Washington University, was retained for another year as director of the Foundation's educational program.

* * *

Col. Millard D. Brown, president of Continental Mills, Inc., Philadelphia, and Alban Eavenson, chairman, Eavenson & Levering Co., Camden, N. J., were the guest speakers at the 37th annual meeting in Philadelphia last month of the textile school fraternity Phi Psi. Col. Brown was elected an honorary member of the fraternity.

Pectic Substance in Cotton and Its Relation to the Properties of the Fibre

By ROY L. WHISTLER, A. R. MARTIN and MILTON HARRIS *

A Textile Foundation Publication

Abstract

Pectic substance has long been known to be present in naturally-occurring cotton fibres. There exist, however, at least two divergent viewpoints regarding the location of this substance in the fibre. The difference in these viewpoints has led to very different conclusions regarding the influence of pectic substance on such important properties of cotton as tensile strength, moisture and dye absorption, and viscosity in cuprammonium hydroxide solutions.

The chief difficulty, heretofore encountered in attempts to evaluate more precisely the role of the pectic substance, has been the lack of a reliable method for its quantitative estimation in the presence of other carbohydrate material. Recently, however, a new method, which permits the accurate determination of small amounts of uronic acids in the presence of large proportions of cellulose, was developed in this laboratory. This development has made possible the present investigation, which concerns itself with the state of the pectic substance in native cotton fibres, its ease of removal by various reagents, its behavior in cuprammonium hydroxide solutions and its influence on the tensile strength and on the viscosity of cuprammonium dispersions of the cotton.

The results indicate that a pectin-cellulose complex does not exist in cotton fibres and that the pectic substance is present as an insoluble salt. The replacement of these ions, under non-hydrolytic conditions, by the monovalent cations, sodium or ammonium, renders the pectic substance soluble.

Cotton freed of pectic substance with alkali showed no change in tensile strength or in viscosity, whereas treatment of the fibre with acids, which removed only a small proportion of the pectic substance, produced an appreciable lowering of these two properties.

* Research Associates at the National Bureau of Standards representing the Textile Foundation.

When dewaxed fibres were dispersed in cuprammonium solutions, it was found that a small portion remained insoluble and was readily removed in a centrifuge. Analysis of the material showed it to consist practically entirely of pectic substance. Similar results were obtained on fibres which had been pretreated with concentrated hydrochloric acid. Consideration of these results led to the conclusion that the pectic substance does not contribute to the viscosity of cuprammonium dispersions of cotton. Determinations of the viscosities of cuprammonium solutions to which had been added several samples of pectic material from different sources substantiate this conclusion.

I. Introduction

POLYURONIDES in the form of pectic substance * have long been known to be present in naturally-occurring cotton fibres. The current concepts regarding the location of this substance *in situ* indicate at least two divergent viewpoints. Anderson and Kerr,[1] for example, have recently presented evidence based on staining reactions and solubility tests which indicates that the pectic substance is restricted to the primary wall. On the other hand, Farr and Eckerson [2] stated that they believed the pectic substance to be the material covering the cellulose particles, the cellulose fibrils, as well as the fibre itself. The differences in these concepts necessarily led to very different conclusions concerning the influence of the pectic substance on many of the important properties of cotton.

Since the experimental evidence on which the previous viewpoints were based was essentially of a qualitative nature, it appeared that more precise information concerning the role of the pectic substance could only be obtained by a quantitative approach to the problem. The principal difficulty heretofore encountered in attempts to do this has been the lack of a reliable method for the quantitative estimation of the pectic substance in the presence of other carbohydrate material. Recently, however, a new method [4] was developed which permits the accurate determination of small amounts of uronic acids even in the presence of large proportions of cellulose. This development has made possible the present investigation, which concerns itself with an examination of the state of the pectic substance in native cotton fibre, its ease of removal by various reagents, its behavior in cuprammonium hydroxide solutions, and its influence on such important properties of the cotton as tensile strength, and fluidity in cuprammonium hydroxide solution.

II. Materials and Methods

The cotton used in these experiments was furnished by the Bureau of Agricultural Economics, United States Department of Agriculture. It was of the Missdel-7 variety, grown at the Delta Experiment Station at Stoneville, Miss., and had been ginned and twice carded but had received no chemical treatments.

The cotton was dewaxed by extraction with cold alcohol and with ether for 24 hours each. The dewaxed cotton had a copper number of 0.18, a

* In this paper the term pectic substance is used to denote that carbohydrate component of native cotton which is characterized by the presence of uronic acid groups.[3]

cuprammonium hydroxide-fluidity of 0.95 rhe, a tensile strength of 89,300 pounds per square inch, and a uronic acid-content equivalent to 2.4 mg. of carbon dioxide per gram of cotton. On the basis of these analyses, it may be considered to represent a high grade natural cellulose.

The copper numbers were determined by a modification [5] of the Schwalbe-Braidy [6] procedure. In order to insure more uniform contact of the cellulose and reagent, the fibres were ground in a laboratory Wiley mill until they passed through a number 20 screen.

Most of the measurements of the fluidities of the dispersions of cotton in cuprammonium hydroxide solutions were made according to the recommendations of Mease.[7] This procedure is essentially that set forth by the Fabrics Research Committee (London) [8] except that the higher concentration of ammonia originally recommended by Clibbons and Geake [9] was used. The cuprammonium hydroxide solution contained 240 ± 5 g. of ammonia (NH_3), 15 ± 0.1 g. of copper, and 1 g. of sucrose per liter. The concentration of nitrite was less than 0.5%. In the present paper this solution will hereafter be referred to as cuprammonium hydroxide solution A. All measurements were made on 0.5% dispersions of cotton at 21° C.

In some of the experiments, a second cuprammonium hydroxide solution, prepared according to the specifications set forth by the Division of Cellulose Chemistry of the American Chemical Society,[10] was used. This solution contained 30 ± 2 g. copper, 165 ± 2 g. of ammonia and 10 g. of sucrose per liter. The concentration of nitrite was less than 0.5%. In the present paper this solution will hereafter be referred to as cuprammonium hydroxide solution B.

Uronic acid determinations were made according to the method developed by Whistler, Martin and Harris.[4] This procedure depends upon an examination of the rate at which carbon dioxide is evolved from a sample during treatment with a boiling solution of 12% hydrochloric acid. The results are recorded either as milligrams of uronic acid-carbon dioxide per gram of material or as percentage pectic substance. The latter value was obtained by multiplying the value for carbon dioxide in percent by the factor 4.8.[4]

Tensile strength measurements were made by the improved Chandler bundle technique.* [11]

III. Experimental Results and Discussion

1. *Extraction of Pectic Substance from Cotton by Different Reagents*

The experiments listed in this section are concerned with a variety of treatments to which cotton fibres have been subjected for various purposes in the course of several different investigations in progress in this laboratory. Accordingly the conditions are not strictly comparable and furthermore no attempt was made to remove all of the pectic substance with each of the reagents used. However, the application of the new method for the determination of uronic acids to the treated samples has made it possible to evaluate quantitatively the efficiency of the different reagents, and for that reason, it appeared advisable to include the results in the present paper.

* Thanks are due Drs. Robert W. Webb and Enoch Karrer of the Division of Cotton Marketing, United States Department of Agriculture, for making these measurements.

(a) *Sodium Hydroxide.* The treatment of cotton with a boiling 1% solution of sodium hydroxide has been recommended [12] for the preparation of standard cellulose. In an earlier investigation [4] it was found that cotton purified in this manner is free from uronic acids. In order to study the efficiency of the removal of pectic substance under these conditions, samples of cotton were similarly treated for different lengths of time. The precedure was essentially the same as that described by Corey and Gray,[12] except that the apparatus of Worner and Mease [13] was employed. The extreme rapidity with which these solutions remove the pectic substance from cotton is shown by the uronic acid determinations in Table 1 and Fig. 1.

TABLE 1

The amount of carbon dioxide evolved, as a function of time, from cotton which had been extracted for different lengths of time with boiling 1% solutions of sodium hydroxide.

Duration of digestion with HCl	Length of time of extraction with sodium hydroxide in hours					
	0	⅙	½	2	4	7½
hrs.	mg/g	mg/g	mg/g	mg/g	mg/g	mg/g
1	1.43	0.29	0.13	0.09	0.15	0.30
2	2.35	0.49	0.23	0.23	0.35	——
3	2.81	0.64	0.47	0.59	0.56	0.60
4	3.16	0.85	0.73	0.78	0.76	0.78
5	3.45	1.09	1.06	1.09	1.01	1.00
6	3.74	1.38	1.36	1.33	1.28	1.29
7	4.04	1.70	1.64	1.60	1.58	1.60
8	4.33	2.01	1.88	1.91	1.87	1.85

Since the carbon dioxide-rate curves for the samples treated for periods of one-half hour or longer are the same and no longer exhibit the initial rapid rise, characteristic of uronic acids, it appears that removal of the pectic substance is essentially complete in a half hour. The good agreement between the data for the samples treated for periods of one-half hour or longer is indicative of the reproducibility of the results obtained by this method.

Cold solutions of sodium hydroxide were much less efficient in removing the pectic substance from the cotton. This was demonstrated by immersing samples for 20 hours in a 1% solution of sodium hydroxide at 30° C. The usual precautions to exclude oxygen from the system were taken. The alkali solutions were always saturated with nitrogen and kept under nitrogen during the time they were in contact with the fibre. After these treatments, the samples were thoroughly washed with a cold, 1% solution of acetic acid and then with water. Analyses showed that the sample still contained an amount of uronic acid equivalent to 1.2 mg. of carbon dioxide per gram of cotton. From a comparison with the value of 2.4 mg. per gram for untreated cotton, it appears that only about 50% of the pectic substanee was removed by the alkali under these conditions.

(b) *Ammonium Hydroxide.* Dewaxed cotton lost only about 10% of its pectic substance during extraction for 18 hours with a cold (0–3° C.) 2%

solution of ammonia. However, when the cotton was first de-ashed by one of two treatments, to be described later, the pectic substance was readily removed under the same conditions. The solubility of the pectic substance of de-ashed cotton is striking, and as will be shown in section 2, use may be made of the phenomenon to isolate the pectic substance from cotton fibres.

(c) *Water.* Cold water was found to be ineffective for removing pectic substance from native cotton while hot water was only slightly more effective. A sample of dewaxed cotton, extracted with distilled water at 90 to

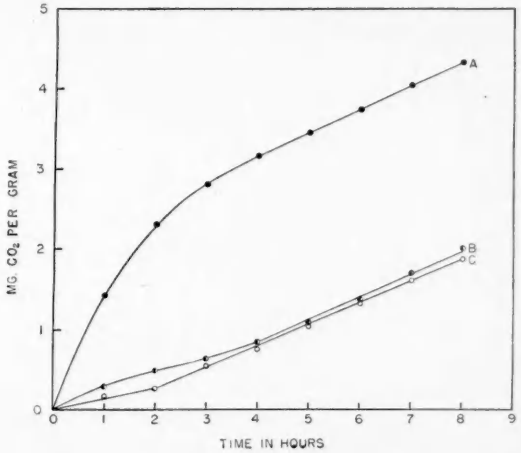

Fig. 1. Rate of evolution of carbon dioxide from dewaxed cotton and from cotton extracted for different lengths of time with a boiling 1% solution of sodium hydroxide. Curve A represents the rate of evolution from raw dewaxed cotton; curve B, the values for a sample treated for 10 minutes, and curve C the value for samples of cotton treated for 0.5, 2, 4 and 7.5 hours. The points for these samples on curve C were so close together that only one set is plotted in the figure.

95° C. for 16 hours, yielded 2.1 mg. per g. of uronic acid-carbon dioxide. This is equivalent to a loss of approximately 12% of pectic substance.

(d) *Ammonium Oxalate.* Ammonium oxalate solutions have been widely used as solvents for the extraction of pectic substance from fibres, fruits, etc. A sample of the dewaxed cotton was therefore subjected to two successive 8 hour extractions with 0.5% solutions of this reagent at 75–80° C. The treated samples were washed with distilled water until oxalate ion could no longer be detected in the washings. Analyses of the treated material showed that it retained only 0.3 mg. of uronic acid-carbon dioxide per gram, and that about 90% of the pectic substance was removed by the above treatments.

(e) *Acetic Acid.* A boiling 1% solution of acetic acid was found to remove less than 50% of the pectic substance in eight hours. On the other

hand, cotton treated overnight with a 96% solution of acetic acid * at room temperature for the purpose of lowering its ash content showed no loss in pectic substance.

(f) *Concentrated Hydrochloric Acid.* A sample of dewaxed cotton was allowed to stand at room temperature (about 30° C.) in a hydrochloric acid solution of sp. gr. 1.18 for four hours. During this treatment, the fibres were degraded to a fine meal which was difficult to filter from the acid solution. The separated material was washed with water until free of acid and air dried. Analyses of the residue indicated that it had lost only about 20% of its pectic substance.

2. *State of the Pectic Substance in Cotton Fibres*

Although some naturally-occurring pectic substance is soluble in warm water, the modification most often encountered is not readily dissolved and appears to become soluble only after chemical treatment. The insoluble material as it exists in the native state has been termed protopectin.[3] This substance, on chemical treatment, is presumably converted to a soluble pectic substance. It is in respect to the nature of the insoluble form of pectin that many differences of opinion have arisen.

Some investigators [14, 15] believe that a pectin-cellulose compound exists, which must first be hydrolyzed, before extraction of the pectin is possible. For example Carré [16] has shown that pectin from several sources appeared to be removed only after treatment with hot dilute acids such as 0.01 *N* hydrochloric or 0.5% solutions of oxalic or citric acids. Others [17, 18] have suggested that natural pectin occurs in combination with certain metallic ions as insoluble salts. In support of this is the finding that calcium pectate is one of the constituents of the middle lamella of plant tissues.[19]

The results described below as well as those of a separate investigation † on the acidic properties of cotton fibres indicate that a pectin-cellulose compound does not exist in raw cotton fibres and that the pectic substance is present on the fibres as insoluble salts of such polyvalent ions as calcium, magnesium, and iron.[20] If such a conclusion is correct, it should be possible to convert the native, insoluble pectic substance in cotton to the soluble form, without hydrolysis or other degradation, simply by substituting monovalent cations, such as sodium or ammonium, for the polyvalent cations mentioned above.

As has previously been mentioned, ammonium oxalate solutions have frequently been used by a number of investigators for the purpose of removing pectic substance from cotton fibres. Presumably, the pectic substance is converted to a soluble form by a process of double decomposition. Unfortunately, this evidence has not been considered conclusive since the extraction process is carried out at elevated temperatures, and the experiments are therefore open to the criticism that some hydrolysis of the pectic substance may have occurred.

The pectic substance can be removed, however, at low temperatures where the possibilities for hydrolysis are at a minimum. In section 1(b), it was shown that cold (0–3° C.), dilute solutions of ammonia had very

* This concentration was suggested by Dr. C. B. Purves, of the Massachusetts Institute of Technology, since he had found that with higher concentrations of acetic acid, some acetylation of the fibre occurred.

† The results of this investigation are being prepared for publication.

little solvent effect on the pectic substance of dewaxed cotton, but that after the fibre had undergone treatments which removed the ash, the solubility of this substance was greatly increased in the same reagent.

The ash was readily removed, either by extraction with a 96% solution of acetic acid or by electrodialysis in distilled water. The ash-free fibre was allowed to stand overnight in a 2% solution of ammonia at 0 to 3° C. Analysis of the treated material showed that about 90% of the pectic substance had been removed. Although there was no evidence of hydrolysis when the 96% acetic acid was used, this procedure may still be open to the same criticism given for the use of ammonium oxalate. This criticism is least applicable to the electrodialysis method of removal of ash, yet the pectic substance from samples so treated was as readily removed as from samples treated with 96% acetic acid. The ease with which the pectic substance is removed from de-ashed cotton was even more strikingly demonstrated in titration experiments (see footnote p. 274), where it was shown that removal of this substance begins when only very small amounts of dilute alkali have been added and the pH of the solution still remains on the acid side of neutrality.

It appeared that it would be of some interest to isolate the pectic substance removed from the de-ashed fibres and compare it with a sample of the material obtained by the commonly used ammonium oxalate method. The material was recovered by the following procedure. The ammoniacal extract was made acid with hydrochloric acid, whereupon a large proportion of the pectic substance precipitated and was removed by filtration. The filtrate was neutralized and concentrated at 40° C. under reduced pressure to a small volume, and the remainder of the pectic substance precipitated by pouring the concentrate into an excess of cold ethanol. The precipitates were combined, dissolved in hot water, and dialyzed for 24 hours. The material was again precipitated by pouring the dialyzed solution into cold ethanol. The precipitate was then filtered off, washed with ethanol and with acetone, and finally dried in air. A comparison of the material with a sample of pectic substance obtained by the ammonium oxalate method is given in Table 2. The values for the uronic acid-carbon

TABLE 2

Comparison of a sample of pectic substance, obtained by extraction of de-ashed cotton with dilute ammonia solutions at 0–3°C, with that obtained from dewaxed cotton by the ammonium oxalate method.

Method of isolation of pectic substance	Uronic acid-carbon dioxide	Fluidity of 0.5% aqueous solutions adjusted to pH 8.1 (temperature 21°C)
	percent	rhes.
Ammonium oxalate	20.8	23
Ammonia	21.1	20

dioxide contents of both samples are in good agreement. The fluidity of the sample obtained by the ammonium oxalate treatment is a little higher and is suggestive of the possibility that a small amount of hydrolysis of the pectic substance prepared by this method had occurred.

3. Relation of the Pectic Substance to Properties of Cotton Fibres

The ease with which the pectic substance is removed from de-ashed cotton fibres, as indicted in the preceding section, strongly suggests that a chemical union between the pectic substance and the cellulose does not exist. Furthermore, it would be expected that if such a combination did exist, removal of the pectic substance would require chemical cleavage of covalent linkages which might result in an alteration of the properties of the fibres. That this does not appear to be the case is shown by the data in Table 3 which relate the pectic content to the tensile strength, copper number, and fluidity in cuprammonium hydroxide solutions of the cotton.

TABLE 3

Relation of pectic substance content of cotton to some of the properties of the fibre.

Treatment	Content of pectic substance	Tensile strength	Fluidity	Copper Number
	percent	100 lbs/sq. inch	Rhes	
(1) Dewaxed cotton	1.15	89.3	0.95	.18
(2) 0.5% ammonium oxalate at 75–80° for 16 hrs.	0.14	89.8	1.1	.02
(3) Boiling 1% sodium hydroxide for 2 hrs.	0.00	94.2	1.4	.01
(4) Concentrated hydrochloric acid (sp. gr. 1.18) at 30°C for 4 hrs.	0.92	0.0	49.0	2.15
(5) Boiling 1% acetic acid for 8 hrs.	.60	86.7	5.7	.20
(6) Electrodialyzed	1.15	100.2	1.4	.02
(7) Electrodialyzed sample treated with 2% ammonia at 0–3°C for 15 hrs.	.19	97.7	1.4	.02

In agreement with the results of earlier workers,[21] it may be seen that there is a relationship between the decrease in tensile strength and the increase in cuprammonium hydroxide fluidity. The most striking feature of these data, however, is found in the comparison of the properties of the fibres which had been treated with reagents such as ammonium oxalate or sodium hydroxide with those of fibres treated with acetic or hydrochloric acids. Cotton fibres, freed from pectic substance by boiling in a 1% solution of sodium hydroxide for 2 hours, exhibited tensile strengths which indicated that no damage had been done to them. Similarly the tensile strength remained unchanged in those fibres from which most of the pectic substance was removed by ammonium oxalate extraction. These treatments appeared to effect an almost negligible increase in fluidity.

On the other hand, treatments with acetic or hydrochloric acid removed much smaller amounts of the pectic substance but produced appreciable changes in tensile strength and fluidity. This was especially noticeable in the sample treated with concentrated hydrochloric acid. The fibre structure was completely destroyed yet the material lost only about 20% of its content of uronic acids. It might be argued, of course, that the hydrochloric acid had destroyed the structure of the pectic substance. Although quantitative evidence is lacking, qualitative examination of a sample of pectic substance, isolated from cotton fibres which had been treated with concentrated hydrochloric acid as described in section 1, showed that it still retained its gelatinous structure and appeared in many ways to be similar to pectic substance isolated by much less drastic methods.

4. *Behavior of Cotton Fibres in Cuprammonium Hydroxide Solutions*

During the preparation of the cuprammonium hydroxide solutions of cotton fibres for fluidity measurements, it was observed that solutions of dewaxed cotton always showed a slight cloudiness, whereas solutions of cotton purified by treatment with a boiling 1% solution of sodium hydroxide (see Section 1–a) were clear. An examination * of the solutions under the microscope revealed the presence of an insoluble material having the appearance of the outer shell of the fibre. No such solid residue could be detected in solutions of the purified cotton. When the cloudy solutions were centrifuged, a small amount of insoluble material was precipitated and the solution became clear.

In order to study the phenomenon further, and to determine the nature of this precipitate, 28.5 g. of dewaxed cotton was dissolved, by shaking for 20 hours, in 4 liters of cuprammonium hydroxide solution A. The resulting cloudy solution was centrifuged until it was practically clear. The precipitate represented 3.22% of the original cotton sample. On analysis, a sample of the precipitate gave the carbon dioxide-rate curve characteristic of uronic acids and yielded 58 mg. of carbon dioxide per gram. From this value it was estimated that 28% of the precipitate was pectic substance and that this accounted for about 70% of the pectic substance in the original sample of dewaxed cotton. When the precipitate was tested with ruthenium red [22] a considerable portion of it was stained red, which indicates the presence of pectic substance. With the iodine-sulfuric acid test, a portion of the material gave a blue color similar to that obtained with cellulose.

The relatively high percentage of pectic substance in the precipitate and the recovery of such a large proportion of the pectic substance of the dewaxed cotton were indeed striking. Since, however, some cellulose appeared to be present in the precipitate, the question immediately arose whether the precipitate was a stable cellulose-pectin compound or whether the pectic substance was contaminated, either with undissolved cellulose or with occluded, dissolved material. Some of the latter was undoubtedly always present since a small portion of the cuprammonium solution was always retained by the precipitate. Although the evidence presented in sections 2 and 3 indicated that a compound of pectic substance and cellulose did not exist, it, nevertheless, seemed advisable to investigate further the nature of the precipitate obtained in this experiment.

* The results of this investigation are being prepared for publication.

Accordingly, the precipitate was resuspended in 200 ml. of fresh cuprammonium hydroxide solution and the mixture allowed to stand for 24 hours, after which the insoluble portion was again removed by centrifuging. This procedure was repeated three times and the final precipitate was then washed with dilute acetic acid, followed by successive washings with acetone and with benzene. The product yielded 150.3 mg. of carbon dioxide per gram, which indicated that the bulk of the cellulosic material had been removed and that the residue consisted largely of pectic substance.

The material which remained in the cuprammonium hydroxide solution originally used to dissolve the dewaxed cotton was precipitated by adding sufficient cold, dilute hydrochloric acid to bring the solution to neutrality. The precipitate was immediately washed with water and acetone, and then dried. On analysis the material gave a carbon dioxide-rate curve identical with that of glucose or cuprammonium rayon,[4] which indicated the absence of detectable amounts of uronic acids.

In order to determine whether the concentrations of copper or ammonia in the cuprammonium hydroxide solutions had special solubility effects with respect to the pectic substance, the same experiments described above were repeated, using cuprammonium hydroxide solution B. On shaking dewaxed cotton (calculated to form 0.5% dispersion) with this solution, the cellulose quickly dispersed, leaving suspended in the mixture numerous bits of insoluble material, which under the microscope appeared to be identical with those described in the previous experiment. Since this cuprammonium hydroxide solution has a greater density than that used in the previous experiment, the insoluble material was somewhat more difficult to remove during centrifuging and a smaller yield was obtained. The material was further purified with fresh cuprammonium hydroxide solution as previously described. The final precipitate was stained a deep red with ruthenium red and was found to yield 153 mg. per gram of uronic acid-carbon dioxide, which indicated again that the fraction insoluble in cuprammonium hydroxide solutions is principally pectic substance.

Finally, the same experiment was done with cotton which had been treated for four hours with hydrochloric acid (sp. gr. 1.18). This treatment is similar to that which Farr [23] states will remove the cementing material, of which one component, it is further stated, is the pectic fraction of cotton fibres. As in the previous experiments, a fraction insoluble in cuprammonium hydroxide solution was obtained, and accounted for a large proportion of the pectic substance of the original fibre. On further purification of this fraction with fresh cuprammonium hydroxide solution, a product was obtained which yielded 164 mg. of carbon dioxide per gram. Qualitative examination of the final precipitate showed that it retained its gelatinous structure and appeared to be similar to the pectic substance isolated by other procedures.

A consideration of the results of the above experiments, as well as those shown in Table 3, leads to the conclusion that the pectic substance does not contribute to the viscosity of cuprammonium hydroxide dispersions of cotton fibres. Further evidence supporting this conclusion was obtained by shaking a 0.1-gm. sample * of pectic substance, isolated from cotton, as well as similar amounts of commercial preparations of pectin (California Fruit Growers Exchange) and pectic acid (Eastman Kodak Company) in 20-ml.

* This is approximately 100 times as much pectic substance as would be present in a regular fluidity determination of cotton.

portions of cuprammonium hydroxide solution A for four days. At the end of this time, none of the materials appeared to have dissolved. Fluidity measurements of the cuprammonium hydroxide solution to which had been added the pectic substance from cotton showed it to be identical with the original cuprammonium hydroxide solution.

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A Tube for Studying Dilute Sediments

By ELLINGTON M. BEAVERS *

A Textile Foundation Publication

Summary

1. *The Kelly tube involves an error because of drainage from the side-arm into the main tube, as pointed out by Duncombe and Withrow.*
2. *It has been shown that this becomes negligible by redesigning the tube.*
3. *A general equation has been derived which permits direct calculation of the percent settled and which does not require that the density of the particle or the concentration of the suspension be known.*
4. *Experimental results are given for the settling of a $BaSO_4$ suspension.*

Discussion

A METHOD for sedimentation analysis of fine particles in dilute suspensions has long been wanting. Methods in common use are not sensitive enough for such cases.

For the study of the rate of settling of a fine clay (Bentonite) suspension, in concentrations of about 1%, some modification of the so-called Kelly tube (Fig. 1) seemed to hold promise of good results.

Kelly [1] derived an equation for use with this type of tube by equating the hydrostatic pressure at the point in the main settling tube at which the side-arm enters to the pressure in the side-arm at that same point, or (Fig. 1):

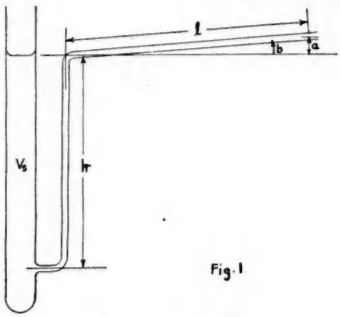

Fig. 1

$$Dh = d(a + h) \qquad (1)$$

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where D is the density of the suspension, and d is the density of the liquid in the side-arm. If the liquid used in the side-arm be of the same density as the dispersion medium, the equivalent of D is

$$D = \frac{W_p + d\left(V_s - \frac{W_p}{d_p}\right)}{V_s} \tag{2}$$

where V_s is the volume of suspension above the point of entrance of the side tube, and W_p and d_p are the weight and density of the particles in suspension, respectively.

The equivalent of a is

$$l \sin b \tag{3}$$

Substituting (2) and (3) in (1), Kelly's equation is obtained in its final form:

$$W_p = \frac{dd_pV_sl \sin b}{(d_p - d)h} \tag{4}$$

In this derivation, it has been asumed that h is constant throughout the observations. Duncombe and Withrow [2] have shown that this assumption will cause large errors in data obtained with a tube built according to specifications suggested by Kelly and others, because of drainage from the side-arm into the settling tube. Since h varies during the run by a quantity Δh, they set up the relation:

$$D(h + \Delta h) = d(a + h) \tag{5}$$

which leads to the expression:

$$W_p = \frac{dd_pV_s(l \sin b - \Delta h)}{(d_p - d)(h - \Delta h)}. \tag{6}$$

However, since Δh is caused by liquid of density d, it can be shown that a more exact equation is:

$$Dh + d\Delta h = d(a + h) \tag{7}$$

which leads to the final form

$$W_p = \frac{dd_pV_s(l \sin b - \Delta h)}{(d_p - d)h}. \tag{8}$$

Duncombe and Withrow also obtained equation (8), but only by neglecting Δh in the denominator of the right-hand member of equation (6). They then defined, for any given tube, a constant, C_1, as the increase in height in the main tube caused by the recession of the meniscus in the side-arm over a distance of one centimeter. Also, for a given tube, sin b is a constant, C_2, and:

$$W_p = \frac{d_pV_sdl(C_2 + C_1)}{(d_p - d)h}. \tag{9}$$

Hence, the error encountered by neglecting Δh is:

$$\frac{C_1}{C_1 + C_2} \times 100. \tag{10}$$

This error has been shown to amount to 25–37.5% for such tubes described in the literature. Except for this factor, the tube should be susceptible to an accuracy of about 1% with reasonable care and precautions; hence, the elimination of the drainage error should result in a valuable laboratory instrument.

Each time a reading is taken Δh might be calculated or measured, but either process would be very laborious and subject to error. If Δh could be made to be of negligible dimensions by redesigning the tube, then an equation of the general form of (4) could validly be used.

That the drainage error is dependent upon the dimensions of the tube is shown by the fact that since by definition,

$$C_1 = \frac{\Delta h}{-l} \tag{11}$$

and since the volume change in the main tube, causing Δh, must be due to exactly the same volume change in the side-arm, the expression for percent error may be modified to:

$$\frac{R_c^2}{R_c^2 + R_v^2 \sin b} \times 100 \tag{12}$$

where R_c is the inner radius of the side-arm capillary tube, and R_v the radius of the main, vertical tube.

The most desirable dimension for R_c is about 2 mm., so that little freedom can be allowed in adjusting this quantity. Also, the magnitude of b, or sin b, is set within close limits by the concentration of the suspension with which the tube will be used. R_v, however, may be varied almost at will without affecting the operation of the tube. It is possible, then, with predetermined values of R_c and sin b, to describe a construction-error curve (Fig. 3) by means of which the necessary diameter of the vertical tube, and accuracy of the apparatus, may readily be decided upon.

The working equation for such a tube is then equation (4) if the density of the medium and of the liquid in the side-arm are the same. If, as is frequently the case, the latter two densities be different, equation (2) must be modified to

$$D = \frac{W_p + d_m\left(V_s - \frac{W_p}{d_p}\right)}{V_s} \tag{13}$$

where d_m is the density of the suspending medium. Combining (13) and (1), there is obtained:

$$W_p = \frac{d_p V_s[dl \sin b + h(d - d_m)]}{h(d_p - d_m)} \tag{14}$$

where all symbols are as previously defined. Of course, if d_m and d be the same, equation (14) simplifies to (4).

To allow direct calculation of the weight settled, w_s, equation (14) may be modified to the form,

$$W_s = \frac{d_p V_s d \sin b}{h(d_p - d_m)}(l_1 - l_2) \tag{15}$$

where l_1 is the reading before settling has occurred, and l_2 is that at any time afterward.

Furthermore, since the weight of the volume, V_s, of suspension, before settling has begun, is equal to the weight of the particles in suspension plus the weight of the dispersion medium, it is true that

$$D_s V_s = d_p V_p + d_m(V_s - V_p) \tag{16}$$

and

$$\frac{V_s}{d_p - d_m} = \frac{V_p}{D_s - d_m}. \tag{17}$$

Combining (17) and (15),

$$W_s = \frac{d_p V_p d \sin b}{h(D_s - d_m)} (l_1 - l_2). \tag{18}$$

Since

$$d_p V_p = W_p \tag{19}$$

where W_p is the weight of particles in suspension before settling begins, it is shown that the weight fraction settled at any given time is

$$\frac{W_s}{W_p} = \frac{d \sin b}{h(D_s - d_m)} (l_1 - l_2). \tag{20}$$

Multiplying this fraction by 100 gives the percent settled directly. The terms in the right-hand member of equation (20) can all be determined with high accuracy. Also, an ever-present source of error in calculations by equation (15) is the fact that the density of a particle in relatively high dispersions may not be, and probably is not, the same as that of a large sample of the pure solid before it is dispersed and peptized. Equation (20) obviates the necessity for knowing d_p.

Description of the Apparatus

For a tube constructed in this Laboratory (Fig. 2), 2 mm. capillary tubing was used for the side-arm which was made to describe an angle of 1° 0′ with the horizontal. Thus, to obtain an accuracy of about 2%, it was necessary that the main tube have a diameter of 10 cm., as shown by Fig. 3. Although this tube was blown from a cylinder of Pyrex, it is suggested that a bottle, of suitable material and dimensions, might serve for the main tube if the other structural features adopted by us were followed.

A ground-glass joint was inserted in the side-arm at A (Fig. 2), to allow the angle which the arm describes to be readily adjustable. A brass, micrometer adjuster, anchored to the frame of the thermostat, held the side-arm firmly by means of a bronze clip on the bulb C′. Scales on the micrometer shaft and head made it possible to calibrate the piece for a range of 0°–6°, after which the angle could be set simply by referring to the calibration curve. The calibration was made while the tube was loaded and in the thermostat, and was accomplished by means of two cathetometers, one vertical and one horizontal.

The joint A was greased for half the distance inward to render it water-tight. A bronze spring across the joint held the two pieces firmly together.

The manometer arm is connected to the main settling tube by the ground-glass joint B. A similar joint, D, fitted with a closed insert, allows

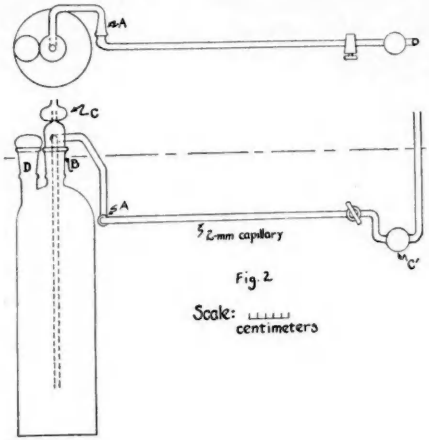


Fig. 2

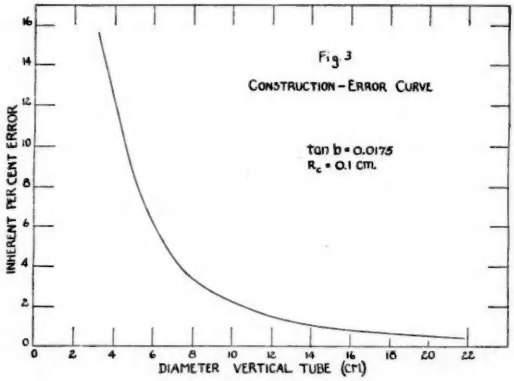


Fig. 3

for making final, small adjustments of the suspension level with a pipette after the manometer arm is connected.

C and C′ are liquid reservoirs to deter evaporation from the system. We have found that these reservoirs, as suggested by Kelly, very effectively prevent evaporation from the system over a 5-day period. If future in-

vestigation over a longer period should show evaporation to be a disturbing factor, the two outlets to the air can readily be connected with a length of rubber tubing, a certain remedy.

With the main tube loaded with a Bentonite suspension, and with water in the manometer arm, it is found that the small meniscus will return to its original position within a few seconds after being disturbed from rest by a distance of 2 cm. by gentle suction at the outer end of the capillary tube. This behavior is used as a test of the cleanliness of the capillary, and great care is recommended on the latter point.

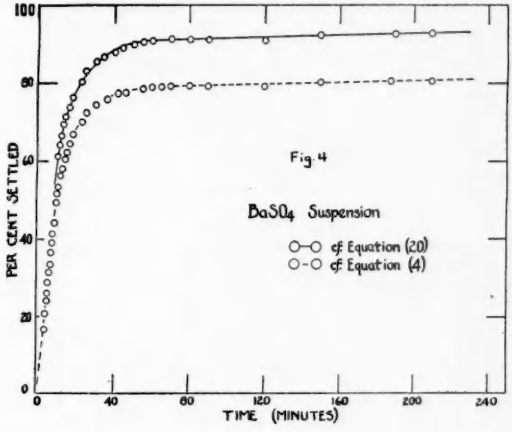
Other advantages in the illustrated construction are: (1) the apparatus may be more readily cleaned, filled and assembled in the thermostat; (2) it is not necessary to completely coat the inside walls of the settling tube with the liquid used in filling the arm; (3) there is no horizontal portion of the manometer arm into which a fine suspension may intrude and settle.

The thermostat was constructed of a frame of angle iron, fitted on the four sides with plate glass, and on the bottom with slate. The temperature in the bath was regulated to $25.0° \pm 0.1°$. A brass receptacle for the main settling tube was adjusted to the true vertical, and drilled into the slate on the bottom and held at the top by a steel cross-bar bolted to the frame of the thermostat.

About eight feet from the thermostat, a horizontal cathetometer was firmly mounted, for making the observations of the position of the meniscus in the side-arm. Since readings of "l" were made along the adjacent side of the hypothetical right-triangle, "tan b" is used instead of "sin b" in the calculations.

Experimental Work with the Improved Tube

A 2% suspension of freshly precipitated $BaSO_4$ was prepared according to the directions of Kelly.[1] The water paste was rubbed with a spatula



on a glass plate for about an hour and peptized with 5% $BaCl_2$ and gelatin solutions. The paste was then gradually diluted to the proper concentration with distilled water.

The density of the suspension before settling was determined by filling a calibrated pycnometer with the mixture while it was being agitated with an efficient stirrer. To obtain the density of the medium, part of the suspension was run through the super-centrifuge at 30,000 R.P.M. and another part at 46,000 R.P.M. The density of each liquid obtained was determined, and was the same as the density of water at that temperature. Neither of the liquids showed a Tyndall effect.

Calculations were made from the data obtained during the run with both equations (4) and (20). The resulting curves (Fig. 4) are at variance about 10%. The curve obtained from equation (20) justifies its derivation as well as the new design of the tube.

I am indebted to Dr. F. K. Cameron for advice and encouragement in preparing this paper and particularly to Dr. J. E. Magoffin for assistance in the discussion of the theory and in the design of the apparatus.

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Viscose Rayon: Stress-Strain Properties

I. Effect of Specimen Length

By H. R. BELLINSON *

A Textile Foundation Publication

Abstract

This is the first report in an investigation of the effects of testing conditions on the load-stretch properties of viscose rayon. This report discusses the effect of changing specimen length.

It is found that increase in length results in a decrease in the breaking strength. The magnitude of the decrease is in good agreement with Peirce's theory of the Weakest Link.

Increase in specimen length also produces an apparent decrease in the per cent breaking stretch. This is probably the result of a jaw effect, in that some extension of the portion of yarn gripped by the jaws may occur.

Introduction

VARIATIONS in the observed properties of any material may result not only from changes in the material itself, but also from changes in the testing technique. In the case of the load-stretch diagrams of viscose, the method of applying load, the rate of loading, the length of specimens, and humidity conditions might all affect the measured properties. These effects have been observed, and will be reported in future papers. This first report discusses the effect of specimen length upon breaking strength and stretch.

Testing

Apparatus.—The apparatus used in these investigations was an inclined-plane testing machine, a type available commercially. This instrument is described in the Appendix. The outstanding advantage of this type of machine is that it tests at a constant rate of load. The rate of loading in a pendulum-type machine, for example, usually varies inversely as the stretch. Since the stretch varies directly with the specimen length, it becomes difficult if not impossible to eliminate the effect of rate of loading in examining the effect of specimen length.

The rate of loading in the present series of tests was 6.04 gm./sec.

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Material.—These tests were performed on Viscose Yarn 150/42, manufactured by the North American Rayon Corporation.

Sampling.—Two specimens of yarn, even if adjacent lengths, show differences in properties. It has not been proven, but it is quite likely, that two specimens taken at some distance apart will show greater differences than two adjacent specimens. This possibility imposes restrictions upon the method of sampling.

It becomes improper to take a length of yarn, divide it into specimens for testing under one condition, and to obtain specimens for another condition of testing from a second length of yarn. Differences observed might be differences in the yarn itself rather than the results of the different conditions of testing.

It is essential that the group of specimens tested under each condition shall fully represent the entire amount of yarn being tested. As a result, all the variations in the yarn will be equally represented in each condition of testing. The variations observed at each condition may now be larger than if the specimens had been adjacent in the yarn, but these variations will appear equally in the averages, so that differences in the averages will be the result of the conditions of testing only.

It is not, however, necessary that each group of specimens represent the entire amount of yarn (a cone) available. It is required merely that the groups of specimens be representative of the same yarn. So that if a single length of yarn be taken from the cone, divided into specimens, and the specimens apportioned to the groups at random, the requirements of proper sampling will have been met. In this way, the variations within each group will be kept at a minimum.

Specimens were actually tested at 5-, 10-, 15- and 20-in. lengths, and 48 specimens were tested at each of these lengths. Four skeins of yarn were unreeled in succession, and cut open, thus providing 80 specimens per skein. From each skein, 12 specimens were taken at random for testing at each length.

Atmospheric Conditions.—All tests were made in an air-conditioned laboratory, with conditions maintained at 70° F. and 65% R.H. to $\pm$ 1° F. and $\pm$ 1% R.H. Within the limits of control, changes are gradual, so that atmospheric conditions are more similar in "adjacent" periods of time than in separated intervals. This presents a situation analogous to that discussed in "Sampling."

Although effects of such small atmospheric variations are undoubtedly minute, yet they may be of comparable magnitude to the effects being measured, so these atmospheric variations must be randomized in the same fashion as were the yarn variations. This requires merely that the order of testing shall not be to complete one group (one length) at one time and a second length at another, even though immediately following, time. Successive tests must be of specimens from different groups. This was accomplished by testing individual specimens in the order of 5-, 15-, 10-, 20-in., and repeat.

Specimen Lengths.—In order to assure known and reproducible specimen lengths, metal gauges were prepared for use with the inclined plane machine. These were designed to hold the movable jaw at a defined distance from the fixed jaw while the specimens were inserted. The gauge lengths were 5.00-, 9.97-, 14.97-, and 19.96-in., as measured by means of a cathetometer.

While the gauge held the movable jaw fixed, the specimen was inserted and clamped in this jaw. The other end was passed through the fixed jaw,

over two glass rods, and attached to a weight of a few grams. This dead weight removed slack. Then this jaw also was closed. The gauge could be removed without stressing the yarn.

Results

Of the 48 specimens tested at each length, several broke at the jaws, and several were seen to be defective while the test was in progress. These were of course discarded, since they were not representative of the material or method of test. Consequently, there remained for analysis 48 specimens at 5 and 20 in., 45 at 10 in., and 44 at 15 in. The average results are summarized in Table I.

TABLE I

Average Breaking Values

Number of Specimens	Length	Strength (gm.)		Stretch (%)	
		Average	Standard Deviation	Average	Standard Deviation
48	5.00 in.	274.32	4.45	24.31	1.16
45	9.97	271.02	2.94	23.45	.66
44	14.97	270.77	3.72	22.83	.61
48	19.96	271.49	4.07	22.51	.62

Discussion

Strength.—Individual specimens show differences in breaking strength. The magnitude of these variations is indicated by the standard deviation. As a result of differences in individual specimens, it may be expected that averages also will show such sampling fluctuations, even though no real difference in strength exists. To discover whether the differences in the averages of Table I are merely sampling fluctuations or are real changes in strength, it is necessary to use the statistical technique of Analysis of Variance.[1]

TABLE II

Analysis of Variance: Breaking Strength

Source of Variation	Sum of Squares	Degrees of Freedom	Variance
Within groups	2683.8489	181	14.828
Between groups	378.1972	3	126.066
Total	3062.0461	184	

$Z = 1.07$ $P < 0.001$

In this technique, the differences in averages (between groups) are compared with the differences within groups, since these latter are a possible source of variations in the averages. The two types of differences are compared in the index Z. Then, on the hypothesis that there are no real

differences in the averages, the probability of obtaining the observed differences (as sampling fluctuation) is computed.[2] This probability was here found to be less than 0.001. It is therefore highly improbable that the observed differences in averages are merely sampling fluctuations, and we may safely assume that there are real changes in strength due only to changing the specimen length.

That specimen length affects the breaking strength of textile materials is a phenomenon that has received considerable attention in the literature. Balls[3] and Midgley and Peirce,[4] in the case of yarns, and Clegg[5] and Brown, Mann, and Peirce,[6] in the case of fibres, found that as the length of the specimen is increased, the average breaking strength decreases. This is the conclusion reached here for viscose yarn.

A test specimen will break at its weakest point, and the strength recorded is that of this weak point. Regardless of how the weak points are distributed along a yarn, the number of such points in a test length will increase as the length is increased; and as the number of weak points increases, the probability that a very weak place will be present also increases. The result is that a longer specimen may break at a lesser load, and therefore the average breaking strength of long specimens will be less than that of shorter specimens.

Peirce,[7] assuming that the distribution of weak places in a material obeyed the Normal or Gaussian law, found that for increases in length up to five times the original gage length, the decrease in strength is very closely proportional to the logarithm of the ratio of lengths. The proportionality constant is the standard deviation of strength in the original gage length; this is an index of the distribution of weak places. If S is the average strength of a unit length, and σ the standard deviation, then Peirce predicts that average strength of longer specimens will be as indicated in Table III.

TABLE III

Length	Strength
1	S
2	$S - .56\sigma$
3	$S - .84\sigma$
4	$S - 1.03\sigma$

The unit length in the present series of tests is 5.00 in. The average strength for this length is 274.32 grams. This, however, is not necessarily the true strength of the rayon in 5-in. lengths, since this average may have deviated slightly from the true value as the result of sampling fluctuations. Therefore it is not desirable to put S equal to the strength of the 5-in. specimens, but rather to fit Peirce's predicted values to the observed values by the least squares method; this amounts to putting the average of the

TABLE IV

Length	Observed Strength	Predicted Strength
5.00 in.	274.32 gm.	274.26 gm.
9.97	271.02	272.11
14.97	270.77	271.03
19.96	271.49	270.30

predicted values equal to the average of the four observed values. The S so obtained depends upon the 185 specimens measured, rather than on the 48 five-in. specimens. The σ used is also the average for all lengths, that is 3.85 gm.

The predicted and observed values are not precisely the same. But this difference may be due to sampling fluctuations, and this possibility must be examined.

TABLE V *

Source of Variation	Sum of Squares	Degrees of Freedom	Variance
Within groups	2683.8489	181	14.828
Departure from theory	124.5845	3	41.528

Z = 0.51 P = 0.04

The probability that the observed differences between the observed and predicted values are due to sampling fluctuations is approximately 0.04; that is, in one test out of 25 will differences as large as these be observed when no real differences exist. If this probability were large, then, Peirce's theory would offer a satisfactory explanation of the changes in strength; if the probability were small, the data would have failed to fit Peirce's theory. P = 0.04 is intermediate; the conclusions are on that uncomfortable borderline where only more data will resolve the uncertainty.

Two other sets of data are presented in Table VI, along with predicted values obtained as for Table IV. These sets represent different yarn from that of Table I, and in addition, these sets were tested without benefit of the metal gauges described under "Specimen Length." There may be

TABLE VI

Set B

Length	Number of Specimens	Observed Strength	Predicted Strength
5 in.	30	270.09 gm.	270.18 gm.
10	30	267.07	267.62
15	30	266.65	266.34
20	30	265.76	265.47
		Set C	
5	27	286.10	286.36
10	27	283.29	282.98
15	27	281.41	281.26
20	27	280.01	280.11

* This is not an Analysis of Variance, but a similar analysis designed to test the hypothesis that the differences between theory and observation in Table IV are merely sampling fluctuations.

errors in individual specimens as large as 0.1-in. This will have a negligible effect upon the average strength, and so the data may be considered here.

Combining sets B and C with the data of Table I into a single analysis similar to that of Table V, we find that the departure from theory is some-

TABLE VII

Source of Variation	Sum of Squares	Degrees of Freedom	Variance
Within groups	8977.5783	402	22.332
Departure from theory	143.1759	9	15.908

$Z = -0.17$ $P > 0.50$

what less than might be expected, on the average, to result from sampling fluctuations. The probability of obtaining deviations greater than those observed, taking the three sets of data as a whole, therefore exceeds 0.50. This resolves the uncertainty of Table V, and it is reasonable to conclude that Peirce's theory of the Weakest Link is a satisfactory explanation of the observed changes in strength resulting from changes in specimen length.

Correlation—Strength: Stretch.—Correlation coefficients [8] were computed for the values of strength and breaking elongation at each specimen length.

TABLE VIII

Coefficient of Correlation

Length	r
5.00 in.	− .014
9.97	+ .257
14.97	− .060
19.96	+ .323
Average	+ 0.132

$P = 0.08$

The average [9] coefficient of correlation is + 0.13. However, if the true correlation were zero, a value of 0.13 might be observed as a sampling fluctuation in one test out of 12 (P = .08). Therefore, the observed correlation cannot be considered significant.

However, the fact that the measured coefficient is not significant does not prove that the true correlation is zero. A value of + 0.13 might reasonably be expected to occur as a sampling fluctuation, in samples of this size, if the true correlation had any value between — 0.02 and + 0.28. The data proves only that the true correlation is less than + 0.28.

Breaking Stretch.—As in the case of the strength, it is necessary to examine the observed differences in breaking stretch, to determine whether they are real differences in extension or are merely sampling fluctuations.

The probability that the differences are sampling fluctuations is seen to be so small that they must certainly be real changes in stretch.

The change in breaking stretch with change in specimen length is not easy to explain. In the case of the strength, the change occurs because a

TABLE IX

Analysis of Variance: Breaking Stretch

Source of Variation	Sum of Squares	Degrees of Freedom	Variance
Within groups	115.5386	181	.638
Between groups	89.6860	3	29.895
Total	205.2246	184	

$Z = 1.92$ $P < 0.001$

strength test measures the weakest portion of a specimen. But the recorded value of breaking stretch is an average value of stretch for all portions of the specimens. There appears to be no way in which a change in the length of the specimen can directly influence the per cent stretch. However, the stretch might be influenced indirectly if there were correlation between strength and breaking stretch; that is, if specimens of high strength also show high stretch, then one can expect that short specimens, having higher strengths, would show greater per cent stretch to failure.

The relation between stretch and strength, assuming correlation, can be expressed by means of the regression equation:[10]

$$y - \bar{y} = r\frac{\sigma_y}{\sigma_x}(x - \bar{x})$$

where y is the breaking stretch corresponding to strength x, $\bar{y}$ is the average stretch ($= 23.28\%$), $\bar{x}$ the average strength ($= 271.94$ gm.), σ_y and σ_x the corresponding standard deviations ($= 0.80\%$ and 3.85 gm.), and r the coefficient of correlation. The greater the coefficient of correlation, the greater the effect on stretch of a change in strength. Using the largest coefficient of correlation that may exist here ($+ 0.28$), the regression equation takes the form:

$$y = 0.058x + 7.51$$

Putting in the smallest and largest observed strengths for x gives a maximum difference in stretch of 0.21%. The observed maximum difference in stretch (between 5- and 20-in. specimens) is 1.80%.

Thus, the effect that correlation between stretch and strength can produce is only one-eighth of the actual effect observed. Even if the correlation were perfect ($r = 1$), as it certainly is not, correlation would account for only two-fifths of the observed effect. Consequently, the observed changes of breaking stretch with change of specimen length cannot be explained as a secondary phenomenon caused by the change in strength.

There remains the possibility that the anomalous behavior * of breaking stretch may be the result of a jaw effect. The jaws of the testing machine were originally flat metal plates with beveled edges. But the

* The data of sets B and C (Table VI) showed the same behavior. Because it was thought possible that this effect might be due to the errors in measuring specimen length, this data was discarded. It is now apparent that the change in stretch is not due to errors in measurement. But this data is still not as good as that of Table I, and is exceedingly bad for computation of correlation.

beveled edges prevented accurate determination of specimen length, so the bevel was removed. This resulted in an excessive number of jaw breaks, and it became necessary to line the plates with Scotch drafting tape, which softened the edges of the jaws.

In making a test, the specimen is stressed between jaws. Since the material is plastic, it is quite likely that the stress does not drop abruptly to zero at the jaw edges, but extends for some distance within the jaws. But stress on the specimen must result in extension. This has a twofold effect. First, since a portion of yarn within the jaws has stretched, then a slight amount of yarn is added to the portion originally between the jaws; this produces an actual addition to the specimen length. Second, that portion of yarn within the jaws which stretches without being pulled clear of the jaws, adds its stretch to the observed stretch; this may be considered an effective increase in length. These effects will not be a function of specimen length, but should be constant for all tests using the same jaws, same yarn, and same technique.

Consequently, various values of x were added to the measured specimen length before determining per cent stretch, and it was found that if the total (effective and actual) increase in specimen length were 0.52 in., then the increases observed in per cent elongation disappear except for residual sampling fluctuation. If correlation is assumed to cause part of the observed decrease in stretch with increased specimen length (using the maximum possible correlation, $r = +0.28$), then the required value of x is 0.38 in. The adjusted values of breaking elongation are given in Table X.

TABLE X

Adjusted Breaking Stretch

Specimen Length	r = 0 x = 0.52″	r = + 0.28 x = 0.38″
5.00 + x	22.02%	22.59%
9.97 + x	22.29%	22.59%
14.97 + x	22.06%	22.26%
19.96 + x	21.94%	22.09%
Average	22.08%	

The actual width of each jaw is 0.55 in., so that there is a total jaw length of 1.10 in. The increase in specimen length on this hypothesis consequently amounts to from one-half to one-third the total jaw length.

If the changes in per cent stretch are due to the hypothesized jaw effect, then there are significant conclusions to be drawn. It is not possible to compare stretches obtained on specimens of different length. This is true, of course, regardless of what causes the change. But if the change is the result of a jaw effect, then the design of jaws and the technique of use (jaw pressure) become factors to be considered. The magnitude of the effective increase in specimen length will depend on the type of jaw used and on the way the jaw is used. Consequently, in comparing results obtained in different laboratories, on different machines, or by different operators, these factors also must be compared.

Appendix

The Inclined-Plane Machine

In the inclined plane machine,[11] one jaw is fixed to a track, the other jaw is mounted on a weighted carriage which is free to move along the track. The track is pivoted, and during the test, the track is inclined, by what is essentially a Scotch Yoke mechanism, in such a way that the rate of change of the sine of the angle of the track (with the horizontal) is constant.

In Fig. 1, the two jaws are marked J; one is fixed to the track T, the other is on the carriage C. The track is pivoted at P, and supported at

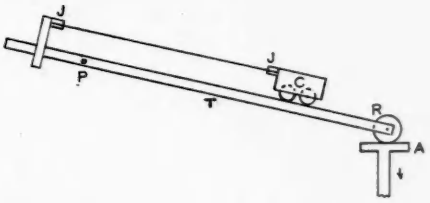

Fig. 1. Operation of Inclined Plane Machine.

R by a wheel resting on platform A. Since R is the center of a wheel, the vertical distance from R to the platform A remains constant. If the platform is moved vertically, the vertical displacement of R (Fig. 2) is ex-

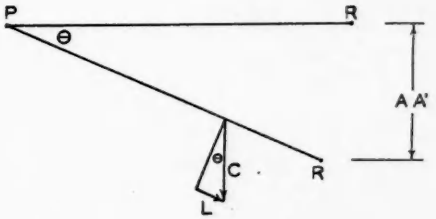

Fig. 2. Load in Inclined Plane Machine.

actly equal to the displacement of the platform, say AA′. The angle θ is then found by

$$\sin \theta = \frac{AA'}{PR}$$

where PR is the distance from the pivot to the end support of the track, and is thus a constant of the machine.

The load L on the specimen held between the jaws is the component of the weight of the carriage C parallel to the track. Referring to Fig. 2,

$$\frac{L}{C} = \sin \theta$$

Therefore:

$$\frac{L}{C} = \frac{AA'}{PR}$$

or

$$L = C \frac{1}{(PR)} (AA')$$

PR, the distance from the point to the end support, is a constant fixed by the design of the apparatus. C, the weight of the carriage, is constant throughout any one test, though it may be changed between tests at will. AA′ is the displacement of the platform. If the platform moves at a constant speed, driven by a constant speed motor, then AA′ has a constant rate of increase, and the rate of increase of load must also be constant.

The load L depends only on the angle θ. Elongation of the specimen results in motion of the carriage, but this has no effect upon the load, except for minor friction and inertia effects.

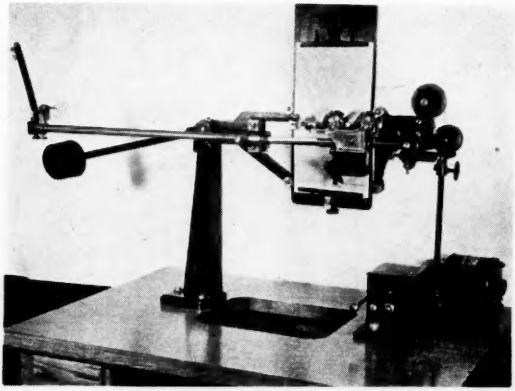

Fig. 3. Inclined Plane Machine.

The recording mechanism is arranged so that a stress-strain diagram is directly obtained upon orthogonal and linear coördinates. The platen upon which the graph paper is held is free to slide vertically between grooves permanently fixed to the track. As the track is inclined, so also is the platen, with the result that the horizontal coördinate of the graph paper remains parallel to the track and the vertical coördinate remains perpendicular to the track.

A pen is attached to the carriage. Motion of the carriage is thus recorded upon the horizontal coördinate, and such motion is precisely the stretch of the specimen. The platen is suspended by means of a wire in such a fashion that its motion in the grooves (motion perpendicular to the track) is proportional to the displacement of the platform. The vertical coördinate of the graph paper is thus directly proportional to the load on the specimen.

The apparatus described here is available commercially.[12] Only minor mechanical changes were made to improve sensitivity and precision.

The jaws consist of flat metal plates, closed by a cam action. Originally, these plates had considerable bevel at the leading edges. This, however, introduces uncertainty into the specimen length, and so the bevel was discarded, and flat plates were used instead. The result was an increase in the number of jaw breaks. In the final arrangement, flat plates were used, and lined with Scotch drafting tape. This reduced the jaw breaks, and reintroduced a slight uncertainty in the specimen length.

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Abstracts

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Address, C. H. Clark, Sec., 65 Franklin St., Boston, Mass.

I. Fibres (Synthetic and Natural) and Fibre Analysis

"Lanital" the Synthetic Wool from Milk, Its Process and Its Output. Antonio Giordano. *Rayon Text. Mo.*, 1939, Aug., P. 45–6; Sept., P. 72–3. (C)

Ramie Fibres, Chemistry of: Method of Degumming and Analysis of the Raw and Degummed Materials. Lilly Gomez and Isabel Concepcion. *Univ. Philippines Nat. & Applied Sci. Bull.*, 1939, V. 7, P. 33–7; abs. in *C. A.*, 1940, V. 34, Col. 889.

Uhi Hakucho ramie fibres from Davao, Mindanao, were heated under 15 lb. pressure for 1½ hr. with a soln. composed of 2% soap and 0.2% palm oil, then bleached with 0.5% NaOCl soln. The white fibrous material obtained was treated under 10 lb. pressure for ½ hr. with a 1% soln. of $Na_2S \cdot 9H_2O$, then bleached again with 0.1% NaOCl soln. The degummed fibre, obtained in 80% yield, was soft, lustrous, strong, contained no lignin, was composed mostly of *a*-cellulose, and had greater dyeing capacity than cotton. Analyses of the raw and degummed materials are included. (C)

Sheep that are Unusual. W. P. Pycroft. *N. Z. Farmer Wkly.*, 1939, V. 60, No. 14, P. 11; abs. in *J. T. I.*, Oct. 1939, P. A610.

A brief illustrated description of a few primitive sheep types. (C)

Shrinkage Tests: Progress in—of Growers' Clips. R. H. Burns. *Ntl. Wool Grower*, 1939, V. 29, No. 7, P. 17–8, 28.

An account of a sampling investigation on the shrinkage of three different lots of wool is given. The results on each entire lot are compared

(1) with results on a sub-lot of 10 bags spaced equally throughout the lot, (2) with results on hand samples taken from the graded sub-lot and scoured in the laboratory. The results of (1) and (2) agreed well, but both differed from the entire lot by as much as 2%. Further tests were made on clips, every fleece of which was graded as it was sheared, to find which method of sampling gave the best representation of grades. It was concluded that equally good results were obtained either by taking every tenth bag or by taking 10 bags made up from fleeces at equal space intervals throughout the clip. A composite bag made from fleeces selected at equal time intervals was not so satisfactory, and the use of less than 10 bags was not recommended. (C)

TEXTILE FIBRES: MECHANICAL PROPERTIES. B. H. Wilsdon. *Text. Wkly.*, 1939, V. 24, P. 453–4; *Times Trade & Eng.*, 1939, V. 45, No. 908, P. vi; abs. in *J. T. I.*, Dec. 1939, P. A785.

A table is given showing the mechanical properties of wool, silk, cotton, and viscose, cellulose acetate, casein and Nylon fibres and the various fibres are compared. The advantages of wool are explained and it is pointed out that its competitors do not approach it in serviceability. Factors determining the "warmth" of clothing, methods of judging fibres, the scale structure of wool and the difficulty of reproducing it in artificial fibres, and the possibility of improving wool and developing its uses are discussed. (C)

WATER OF CONSTITUTION AND WATER OF HYDRATION OF ANIMAL AND VEGETABLE TEXTILE FIBRES. A. Baroni. *Gazz. chim. ital.*, 1939, V. 69, P. 435–43; abs. in *C. A.*, 1940, V. 34, Col. 269. (C)

WOOL MANUFACTURE: WEATHERING OF THE FLEECE IN RELATION TO. P. R. McMahon. *Proc. 8th Annual Meeting of Sheep Farmers (N. Z.)*, June 1939, P. 35–41.

Defines "tippy wool" and other defects in the wool fibre due to weathering, emphasizing for the benefit of wool growers, to whom the lecture is directed, the trouble and expense in manufacturing caused by weather-damaged wool. To eliminate tippiness in wool he would avoid breeding from sheep thus affected; he also advises protection of the fleece by "rugging," and believes that some suitable agent in a sheep dip might improve the staple tips. (C)

X-RAY DIFFRACTION INVESTIGATION ON A HOMOLOGOUS SERIES OF CELLULOSE FIBRES. E. Plötze and H. Person. *Naturwissenschaften*, Oct. 13, 1939, P. 693; abs. in *Eastman Kodak Abs. Bull.*, Jan. 1940, P. 42.

A change in the degree of polymerization of 800 to 3,000 does not produce any substantial change in the mechanical properties of cellulose fibres. From 800 to 200, an appreciable diminution in tensile strength is observable, and at lower values the fibre characteristics disappear. An X-ray diffraction examination of two homologous series from ramie and from cotton showed that the Debye-Scherrer diagram remains unchanged with a change in the degree of polymerization of 3,000 to 200. (S)

X-RAY STUDY OF PROTEINS AND RELATED STRUCTURES. W. T. Astbury. *Science Progress*, July 1939, P. 1–19; abs. in *Eastman Kodak Abs. Bull.*, Oct. 1939, P. 540.

A review is given of the present status of protein structure with particular reference to X-ray diffraction evidence. The correlation of fibrous,

globular, and nuclear proteins is clearly stated, and possible future investigations of chromosome and virus structures are indicated. (S)

II. Yarns and Fabrics

Automatic Steam Sterilizer. *Text. Recorder,* Nov. 6, 1939, P. 36, 38.

A new machine for sterilizing textile materials such as surgical dressings, lint and bandages, uses a vacuum as high as 27 in. Hg. for initial exhaustion of air from the autoclave. With a 25 lb. gauge as the limiting pressure this gives a compression ratio of the steam entering the autoclave of 23:1. A unique feature of this sterilizer is an automatic wave pressure introduced in the autoclave that is maintained throughout the sterilizing period and ensures steam movement throughout the treated mass at all times. (C)

Baddeley Shuttleless Loom. C. H. Baddeley & Co. *Text. Mfr.,* Oct. 1939, P. 447, 457.

A double-pick loom suitable for the weaving of many heavy materials. The usual picking arrangements are replaced by a large drum and steel tapes. The tape carries a bronze eye at the end, through which is threaded the weft from a stationary cone of yarn. The drum is revolved and the steel tape is so guided that it is projected straight. After the carrier eye has passed through the warp shed and beyond the other selvedge, a lever-mounted pin carried on the sley passes through the weft loop and holds it while the tape returns and the double pick is beaten-up. A double-pick is then inserted from the other side, making a good selvedge at each side. (C)

Bleached Wool: Cause of Yellowing. *Bull. Trim. Lab. Anal. et Lech. Ind. Roubaix,* 1939, No. 43, P. 19–21; abs. in *J. T. I.,* Nov. 1939, P. A722.

An account is given of the examination of a sample of combed wool that acquired an uneven yellow color on bleaching with hydrogen peroxide in the presence of ammonium pyrophosphate. The yellow sample had been machine-bleached and the layers of material on the bobbin filtered the bleaching liquor. The yellow coloration is therefore attributed to the presence of manganese and it is suggested that this may be due to contact with corroded equipment made of steel containing manganese. (C)

Bleaching of Cellulose, with Special Reference to Bast Fibres. E. Butterworth. *J. Soc. Dyers Col.,* Dec. 1939, P. 589–96.

The author states that his description of certain observations, made in an attempt to work out a technical process for all cellulose materials, is put forward neither as a summary of the considerable work done on the question of bleaching nor as a basis for the discussion of the theory of the bleaching reactions. Rather it suggests that in the initial stages of degradation, such as may necessarily occur during bleaching, small changes in procedure are of considerable effect, and it points to the possibility that by control of such procedure any cellulosic material may be bleached without alteration over a wide range of conditions. While such observations refer directly mainly to linen cellulose, similar relations have been obtained on other celluloses. (C)

BLENDING STAPLES TO INCREASE STRENGTH. Anon. *Cotton*, Jan. 1940, P. 46–8.

It is agreed by several spinners who discuss the subject that any increase in yarn strength resulting from the blending of cottons varying in classified staple length much more than 1/16 inch is more than offset by decreased yarn evenness. None of those discussing the subject suggest the selection of cotton of the same grade and staple length, but of finer fibre diameter (fibre weight per inch). The greater the number of fibres in the cross-section of a yarn, the greater the strength of that yarn—other fibre properties being equal. (C)

CARBONIZING WOOL-ACETATE. *Text. Wld.*, June 1939, P. 71.

Pre-saponification of mixtures suggested. (C)

CASEIN FIBRE-WOOL MIXTURES: PRELIMINARY TREATMENT, DYEING AND FINISHING. *Mell. Textilber.*, 1939, V. 20, P. 507–11.

A general account is given of methods for the preliminary treatment, including such processes as oiling, sizing, designing, washing, carbonizing, fulling, bleaching, etc., and the dyeing and finishing of textile materials composed of mixtures of casein fibres and wool. (C)

CONTINUOUS PEROXIDE BLEACH. *Text. Wld.*, June 1939, P. 63.

Description of new process developed by Du Pont. (C)

(NEW) COTTON CORD CONSTRUCTIONS: CLAIMS FOR. *Text. Mfr.*, Oct. 1939, P. 430, 460.

The basic principles, as far as disclosed in patents, underlying "low-stretch" or stretchless cords for motor tires or rubberized belting (cotton and rayon). (C)

COTTON SPINNING EQUIPMENT AND ITS ADAPTABILITY TO RAYON STAPLE FIBRE. James L. Truslow. *Rayon Text. Mo.*, 1939, June, P. 57–8; July, P. 59–60.

Paper read at May 1939 meeting of A. A. T. T. in New York. (C)

COTTON YARNS: DOUBLING AND CABLING. J. Dyson. *J. T. I.*, Nov. 1939, P. P431–40.

Treats in condensed form the various problems relating to the doubling and cabling of cotton yarns and the most efficient methods of preparing yarns for those processes. Commends the disc doubling frame as especially suitable for high twist doubled yarns, noting particularly the regularity of twist and evenness of yarn tension. Also of interest is the description of a laboratory twisting device for experimental doubling and cabling, and for analyzing the resultant cords. (C)

DRY CLEANING: APPLICATION OF—TO MILL PROCESSES. Roland E. Derby. *Am. Dye. Rptr.*, Sept. 4, 1939, P. 520–9, 537–8.

Describes the problems encountered and solved in the development of a successful continuous dry cleaning machine, using trichlorathylene as a solvent, for the removal from woolens and worsteds of tar, paint, oil, stains and other extraneous substances. Cost per pound is low as some 98% of the solvent is recoverable. In subsequent finishing processes there is a sub-

stantial saving in cost and time, and the natural fibre properties are subjected to less damage. (C)

FINISHED TEXTILES: RESISTANCE TO WEAR. O. Mecheels. *Mell. Textilber.*, 1939, V. 20, P. 565–9.

It is pointed out that finishing treatments frequently reduce the resistance of textile materials to wear even when they do not produce losses in tensile strength. Data are given showing the effects of chlorination and of mechanical and chemical damage on the strength and resistance to wear of wool, and of mercerization and various bleaching treatments on the properties of cotton. It is suggested that the observed loss in resistance to wear is due to damage or removal of the wool scales or cotton cuticle, especially to removal of the fatty and waxy materials they contain, in these finishing treatments. The loss in resistance to wear produced by ether extraction of cotton confirms this view of the protective action of cotton wax. The loss in resistance to wear of wool, cotton and viscose yarns produced by ether extraction can be restored to a considerable extent by brightening treatments, *e.g.*, with soap or Turkey red oil, soap being preferable for the treatment of cotton yarn and oil for wool yarn. The treatment of rayon and cotton materials with synthetic resins for the production of crease-resisting and permanent finishes reduces the resistance of the materials to wear, the loss being less if the resins are applied in a finely-divided form after condensation than in the case where the resin is formed in the material. It is suggested that protection against wear might be attained by deposition of a suitable resin on the fibre in the form of a film. Hard deposits in the fibre should be avoided and there is need for the development of resins which will be very ductile even in a fine state of division. Rayons could be given protection against wear similar to that provided by the structure of the natural fibres if protective films of synthetic resin, protein, wax or fatty materials could be applied and made resistant to washing. (C)

FINISHING OF MODERN ALL-SPUN RAYON FABRICS. B. S. Hillman. *Rayon Text. Mo.*, 1939, June, P. 63–4; Nov., P. 63–4; Dec., P. 68–9. (C)

HAND IN TEXTILES AND ITS RELATION TO UNDERLYING STRUCTURE. Jerome Alexander. *Am. Dye. Rptr.*, Sept. 18, 1939, P. 557–66.

In this paper, presented at meeting, New York Section A. A. T. C. C., May 1939, the author divided it into two apparently separated but really mutually dependent sections, first, the chemical and physical aspects of fibres and etxtiles; and second, the structure and behavior of the human nervous system with respect to the determination of what we call hand. While the author made it very plain that "hand" and its measurement is a highly complex problem, and indicated the principles involved, he had no measures of "hand" to recommend, but did say that "whenever an instrument is proposed or considered, we must take into consideration the basic principles governing the determination of hand, and see how close that instrument comes to fixing any fact which is of value." (C)

KAPOK AND FLAX UNIONS. *Linen Trade Circ.*, 1939, V. 26, No. 1337, P. 2; abs. in *J. T. I.*, Nov. 1939, P. A700.

Claims it is now possible to produce a kapok yarn on an industrial basis. The yarn is said to be suitable for mixing with almost any other fabric, and

that samples produced reflect all the well-known characteristics of kapok, *i.e.*, extreme warmth and lightness, with good waterproof and moth-proof properties. (C)

NON-KIER BOIL METHOD REDUCES BLEACHING TIME. Anon. *Daily News Record*, July 14, 1939, P. 11.

Describes a three-hour continuous method for bleaching cotton piece goods which uses one reagent for removal of waxes and starches, and another for removal of motes and shives. (C)

RAMIE AND ITS MANUFACTURE. Clifford Carter. *Indus. Fibres Review*, 1939, V. 4, No. 2, P. 37–41; abs. in *J. T. I.*, Sept. 1939, P. A562. (C)

RAYON: HANDLING—IN THE MILL. *Text. Wld.*, Sept. 1939, P. 81–5.

Practical pointers on blending, throwing, weaving, knitting and finishing. (C)

RAYON AND STAPLE FIBRE YARNS: SIZING. H. Brandenburger. *Zellwolle*, 1939, V. 5, P. 240–1; abs. in *J. T. I.*, Nov. 1939, P. A698.

A brief discussion of the need for care in the handling of rayon and staple fibre yarns, the advantages of the use of sizing machines provided with drying cylinders, and types of sizing materials used for rayon and staple fibre yarns. (C)

RUBBER LATEX: IMPREGNATION OF TEXTILE FIBRES WITH. B. A. Harold. *Am. Dye. Rptr.*, May 15, 1939, P. 255–60.

In this article the author presents a study of two groups of colloidal bodies, rubber latices and textile fibres, from the standpoint of producing a fibre which has been perfectly impregnated by the latex. It is apparent that the molecular aggregates of latex are of such size that they do not permit true impregnation. However, methods have been devised by which the disadvantageous properties of a "rubber surface" may be eliminated. (C)

SEMI-RESIN FINISHES FOR COTTON PIECE GOODS. W. W. Trowell. *Am. Dye. Rptr.*, Oct. 30, 1939, P. 643–6.

Describes a new type of thermoplastic resins which show exceptional compatibility with starches, softeners, mineral oil, waxes, gums, gelatin, latex, sulfonated oils, and other materials commonly used in finishing. The excellent stability of emulsions of these resins makes it possible to produce a wide variety of semi-resin finishes showing marked utility in the finishing of cotton piece goods. A description of the handling of such resins in back-filling and pure finishing, together with attendant advantages and limitations, is presented. Also cited is the fact that these advantages can be obtained without an increase in over-all finishing costs. (C)

SPUN RAYON SYMPOSIUM. *Text. Wld.*, Dec. 1939, P. 54–9.

The following papers presented at annual meeting of Textile Division of A. S. M. E. in Philadelphia, Pa., Dec. 6, 1939, are published in large part: Producing Spun-Rayon Yarns, by Carl D. Brandt; Spun-Rayon Weaving, by Albert Palmer; Spun-Rayon Finishing, by Harold DeWitt Smith. (C)

STARCH PRODUCTS USED IN THE SIZING OF RAYON. Jerome Senechal. *Rusta-Rayonne*, 1939, V. 14, P. 333–9; abs. in *C. A.*, 1939, V. 33, Col. 9656.

A general description and discussion of the properties of starch products and gums used for sizing and of the methods used for their chem. analysis and for their practical evaluation. (C)

TEXTILE DRYERS OF TOMORROW. B. R. Andrews. *Am. Dye. Rptr.*, Sept. 4, 1939, P. 530–7.

Paper presented at meeting, Piedmont Section, A. A. T. C. C., Feb. 1939. Outlines the probable characteristics of tomorrow's dryers used in the preparation of woven goods, and shows ways in which these features can or have been combined into workable units; also indicates the combinations that appear most likely to give best results and the most economical production per unit, and also outlines a method of checking actual production against possible capacity. (C)

TEXTILES OF TOMORROW. Kenneth H. Barnard. *Am. Dye. Rptr.*, Dec. 25, 1939, P. 737–41.

Paper presented at meeting, North Jersey Section, Am. Chem. Soc. (C)

WARP-KNITTING ESSENTIALS. Otto Engelhard. *Text. Wld.*, Dec. 1939, P. 65.

Discusses the selection, installation and operation of high-speed tricot machines. (C)

WATER REPELLENT: NEW TYPE. George A. Slowinske. *Am. Dye. Rptr.*, Oct. 30, 1939, P. 647–50.

This new type of water repellent combines with textiles to form a water repellent complex. The new agent is a single chemical compound, is distinct in character from older type products, and is known as Zelan A. (C)

YARN AND FABRIC TRENDS IN EUROPE AND AMERICA. H. W. Rose. *Rayon Text. Mo.*, 1939, July, P. 51–2; Aug., P. 40–2; *Am. Dye. Rptr.*, Sept. 4, 1939, P. 499–500, 543–6.

Paper presented before A. A. T. T., June 1939. Describes the newest synthetic products and their properties. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

PHTHALOCYANINES: NEW CLASS OF SYNTHETIC PIGMENTS AND DYES. Miles A. Dahlen. *Am. Dye. Rptr.*, Oct. 16, 1939, P. 603–10, 620–1.

The phthalocyanines are blue-to-green pigments and dyes containing the first new chromophore of commercial importance developed in a quarter of a century. Although closely related structurally to chlorophyll and hemin, there is no evidence that they occur in nature. The chemical and industrial history and scope of the development are reviewed. (C)

PRINTING PASTE THICKENERS: MOISTURE ABSORPTION IN THE STEAMING PROCESS. H. Gerber and P. Grunn. *Mell. Textilber.*, 1939, V. 20, P. 439–40. (C)

RAYON: EFFECTS OF RESIDUAL SULFUR IN. M. Cordier and H. Tatu. *Rusta-Rayonne*, 1939, V. 14, P. 155–63; abs. in *C. A.*, 1939, V. 33, Col. 9655. (C)

RESINS FOR TEXTILE APPLICATION: RECENT DEVELOPMENTS OF. D. H. Powers. *Am. Dye. Rptr.*, Sept. 4, 1939, P. 515–9, 537.

Paper presented before N. Y. Section, A. A. T. C. C., Mar. 1939, and relates to the tremendous progress in the last few years in the modification of textile fabrics with small amounts of resins so that the resulting fabrics look and feel like ordinary fabrics, although they may be much stronger, much more resilient or much more resistant to slippage or shrinkage. The author indicates that whether the next few years will see the greatest development in all resin fabrics or resin modified natural fibres depends on how actively we put these resins—these new building tools—to work to help us with our problems. The stenographic report of the discussion that followed the paper contains many interesting facts regarding resin finishes. (C)

SAMPLING IN TEXTILE PRINTING: METHODS AND USES OF. "Technicus." *Rayon Text. Mo.*, 1939, June, P. 72–3; July, P. 65–6. (C)

SILK HOSIERY DYEING METHODS, PAST AND PRESENT. Louis S. Zisman. *Am. Dye. Rptr.*, Sept. 4, 1939, P. 489–92. (C)

SODIUM SULFATE ERROR IN MEASURING ACID CONTENT OF CARBONIZING BATHS. H. C. Olsen and W. B. Prescott with H. C. Chapin. *Am. Dye. Rptr.*, Nov. 13, 1939, P. 669–71.

The exact effect of sodium sulfate on both gravity and conductance measurements of sulfuric acid concentration, with other influences, such as temperature change and the inaccuracies of ordinary hydrometers, excluded, is determined and the results are tabulated and discussed. (C)

SOLUBLE CHROMIUM DERIVATIVES OF DYESTUFFS. James L. Boyle. *Am. Dye. Rptr.*, Dec. 25, 1939, P. 741–4.

The introduction of soluble metallic derivatives of mordant dyestuffs has made it possible to obtain by a substantive dyeing process results which previously could be produced only by mordant dyeing. This article describes this development from the point of view of a chemist. (C)

STAPLE FIBRE: DYEING WITH VAT DYES. *Klepzig's Textil-Z.*, 1939, V. 42, P. 476–7; abs. in *J. T. I.*, Nov. 1939, P. A706.

Difficulties experienced in the dyeing of staple fibre in apparatus used for dyeing cotton of the type in which the dye liquor is caused to circulate through loose fibre or wound packages of yarn are discussed and shown to be due mainly to the greater swelling of staple fibre and, in dyeing with vat dyes, to the use of alkali. These difficulties may be overcome by a method similar to the pigment padding process used for piece-goods. (C)

SULFAMIC ACID: TEXTILE CHEMICAL USES OF. J. Wakelin. *Am. Dye. Rptr.*, Dec. 11, 1939, P. 729–31. (C)

SURFACE ACTIVE AGENTS: THEIR APPLICATIONS IN THE WET-PROCESSING OF TEXTILES. Part 1–3. Andrew J. Kelly. *Cotton,* 1939, Nov., P. 51–3, 7; Dec., P. 61–3, 108; Jan. 1940, P. 53–5.

The first two instalments of this discussion reviewed the general history of wetting agents, and the close relationship of penetration to detergency in textile wet-processing. The author described the accepted tests for evaluation of wetting agents, and gave a discussion of the several different classes of products used as surface active agents in textile work; also the soaps, the sulfonated (sulfated) oils, the soluble solvent compounds, and the synthetic surface active agents and "synthetic detergents." He then discussed the requirements of a wet processing aid, the textile applications, and the need for simpler tests for detergency, etc. In the final instalment of this series he discussed wet-processing for Sanforizing, the newer cation active finishing agents, etc. (C)

SURFACE CATION ACTIVE COMPOUNDS IN THE TEXTILE INDUSTRY. Jacob Katz. *Am. Dye. Rptr.,* Nov. 13, 1939, P. 671–4.

Paper presented at Annual Meeting, A. A. T. C. C., Boston, Sept. 16, 1939. (C)

SYNTHETIC RESINS IN RESIST PRINTING. J. Morellon. *Rusta-Rayonne,* 1939, V. 14, P. 238–41; abs. in *C. A.,* 1939, V. 33, Col. 9651.

A brief review of the results obtained with CH_2O-amine, glycerol-phthalic acid and phenol-CH_2O resins. (C)

TEXTILE PRINTING: RECENT DEVELOPMENTS IN. P. J. Wood. *Am. Dye. Rptr.,* Sept. 4, 1939, P. 493–4, 542–3. (C)

TINTINOL PROCESS. H. L. Siever. *Am. Dye. Rptr.,* Oct. 16, 1939, P. 612–3.

A tinting process for cut staple rayon that offers three desirable factors, namely: moisture, in many cases fibre lubrication, and color tinting. With these factors available and when applied in the opener rooms the treated stock is sufficiently mixed at the pickers, so that the mass of fibres are claimed to take on a characteristic tenacity similar to good running cotton. (C)

VISCOSE AND MIXED TEXTILES: DEVELOPMENT OF CONDITIONS FOR AN EVEN DYEING OF—BY SUBSTANTIVE DYES. K. M. Markuz. *Khlopchatobum. Prom.,* 1938, No. 2, P. 42–7; abs. in *C. A.,* 1939, V. 33, Col. 8997. (C)

IV. RESEARCH METHODS AND APPARATUS

ABRASION TESTING APPARATUS: IMPROVED. W. Davis and G. H. Buckley. *J. T. I.,* Sept. 1939, P. T133–6.

Further improvement in the Buckley apparatus for testing abrasion on knitted fabrics, described in *J. T. I.,* 1935, *25,* T133–40, involves redesigning of the machine so that the fabric under test is made to rotate while it is under the action of the rubbing arm and a much better grip is now exerted between the two surfaces, the fibres being kept in a constant state of movement and change. The test is thereby much more searching and the operation of rubbing the ordinary types of knitted fabrics into a hole can be accomplished in a short space of time. (C)

ARTIFICIAL FIBRES (STAPLE FIBRE): DETERMINATION OF—IN MIXTURES CONTAINING COTTON AND OTHER VEGETABLE FIBRES. Arnaldo Cappelli and Riccardo Tuffi. *Ann. chim. applicata*, 1939, V. 29, P. 231–40; abs. in *C. A.*, 1940, V. 34, Col. 268.

The method consists in extg. the fibres in a boiling soln. of basic ZnClO, which dissolves the artificial fibres, leaving cotton or other vegetable fibres intact. A 60° Bé. soln. of ZnClO soln. is used (sp. gr. 1.835). (C)

BREAKING STRENGTH OF SIZED AND UNSIZED YARN. Edward Wood. *Cotton*, Jan. 1940, P. 45.

Illustrates and describes a method of running extra ends through the slasher, and then testing them for strength, size absorbency, etc. (C)

CELLULOSIC MATERIAL: CRYOSCOPIC DETERMINATION OF MOISTURE. M. Milone and E. Grandis. *Annali Chim. Appl.*, 1939, V. 29, P. 130–4 (through *Brit. C. A.*, 1939, P. B812); abs. in *J. T. I.*, Nov. 1939, P. A718.

The moisture in textile fibres can be detd. by measuring the f.-p. lowering of CCl_3CO_2H by the H_2O present in the fibre. The Beckmann app. is used. The moisture is detd. by the formula: $\% H_2O = (\Delta \times 18.016 \times p_o)/(122.7 \times p)$, in which Δ is the f.-p. lowering, 18.016 and 122.7 are the mol. wts. of water and the acid, resp., and p_o and p are the wts. of acid and fibre used, resp. (C)

FIBRES: DENSITY AND INTER-MICELLAR SPACING. Y. Matsunaga. *Mem. Kyoto Coll. Sci.*, 1938, V. 21, P. 219–32 (through *Sci. Abs.*, 1939, V. 42, P. 635); abs. in *J. T. I.*, Nov. 1939, P. A718.

Inter-micellar spaces of various textile fibres have been calculated from measurements of densities and swelling in water, primary alcohols and liquid paraffins. The density was greatest in methyl alcohol and decreased with the number of C atoms in the alcohols and paraffins. (C)

FINISHING MATERIALS: ANALYSIS AND TESTING. J. Rière. *Tiba*, 1938, V. 16, P. 321–5, 353–63, 415–21; abs. in *J. T. I.*, July 1939, P. A485.

A general account is given of methods for the analysis and testing of starches, soluble starches, dextrins, glucose, various gums and mucilages, glues and gelatins, diastases, formaldehyde and ultramarine blues for use in finishing processes. (C)

FLAX AND TRUE (SOFT) HEMP: DISTINGUISHING BETWEEN. *Linen Trade Circ.*, 1939, V. 26, No. 1338, P. 3; abs. in *J. T. I.*, Nov. 1939, P. A720.

It is stated that flax and hemp are very similar in structure and that identification is difficult. The following tests are described: (1) The moisture test. (2) Potassium dichromate test. (3) Cross-sections. (4) Cuprammonium solution test. (5) The cyanin test. (C)

GREASE IN WOOL SCOURING LIQUORS: RAPID CONTROL METHOD FOR. Joseph W. Creely and George C. LeCompte. *Am. Dye. Rptr.*, Oct. 30, 1939, P. 627–9. (C)

HAND MICROTOME FOR FIBRES. A. Herzog. *Mell. Textilber.*, 1939, V. 20, P. 545–50.

A simple type of hand microtome for use in cutting fibre cross-sections is described and illustrated. It can be used equally well with all fibres, even

cotton and degummed silk, and enables thin sections of 10–30 μ to be cut without any difficulty. The fibre sections are well-defined and permit all deposits of impurities, etc., to be clearly observed. "Peru glue" is recommended as embedding agent as it is readily removed by benzene or carbon tetrachloride, and it may be tinted with Safranine if desired. Excellent photomicrographs of cross-sections of bundles of fibres cut with this hand microtome are included. (C)

HEMP: DETERMINATION BY CHEMICAL MEANS OF—IN TEXTILES COMPOSED OF MIXED FIBRES CONTAINING COTTON. Part I. A. Capelli and R. Tuffi. *Ann. chim. applicata*, 1939, V. 29, P. 225–31; abs. in *C. A.*, 1940, V. 34, Col. 270.

Hemp is dissolved out of mixts. with cotton by means of an ammoniacal Cu soln. The soln. is prepd. by dissolving 10 g. $CuSO_4$ in 100 cc. H_2O. Then 14 cc. coned. NH_4OH is added, drop by drop, until the ppt. first formed is redissolved. One hundred and fifty cc. of 15% NaOH soln. is then added, and the ppt. filtered off. It is redissolved in 20 cc. coned. NH_4OH, and the filter washed with NH_4OH until 250 cc. has been added. This soln. contains 0.85% Cu. The cotton remains undissolved in this reagent. (C)

HUMIDITY: CONTROL OF—AND CONSTRUCTION OF A CONSTANT TEMPERATURE AND HUMIDITY CABINET FOR LABORATORY USE. F. E. Humphreys. *J. Intern. Soc. Leather Trades' Chemists*, May 1938, V. 22, P. 224–32; abs. in *Eastman Kodak Abs. Bull.*, May 1939, P. 300.

It is concluded that hair hygrometers are only reliable over a very small range about the point at which they have been set, and that saturated salt solutions are satisfactory as humidity controllers only in small vessels. A cabinet is described in which the temperature and humidity are maintained constant and independent of external conditions. (S)

HYDROGEN ION: DETERMINATION BY COLOR ANALYSIS. A. G. de Almeida. *Mikrochemie*, 1939, V. 26, P. 9–21; abs. in *J. T. I.*, May 1939, P. A349.

An experimental principle for the measurement of hydrogen ion is established by means of which the pH value of a solution can be found by measuring the hue and saturation of the color given by a known indicator. (C)

MATCHING TO SAMPLE. *Text. Recorder*, June 6, 1939, P. 36–7.

In the first instalment of this article the author described how the Pulfrich Photometer is used to ascertain lustre value. In this instalment its use as a colorimeter with the supplementary Krüger Apparatus is described. (C)

MICROSCOPICAL ANALYSIS OF MIXED FABRICS: QUANTITATIVE. Hazel M. Fletcher. *Am. Dye. Rptr.*, Oct. 16, 1939, P. 624–6. (C)

MOISTURE IN FELT ARTICLES: DETERMINATION OF—BY THE XYLENE METHOD. Levin and S. Trakhtenberg. *Sherstyanoe Delo*, 1938, No. 3, P. 47–8; *Khim. Referat. Zhur*, 1938, V. 1, Nos. 11–12, P. 196; abs. in *C. A.*, 1939, V. 33, Col. 9657.

To 20 g. of felt in a metal flask, add 200 cc. of xylene, close with a stopper carrying a tube that leads to an absorber, and proceed as in Dean

and Stark's method (*C. A., 14,* 2145). The method gives results 0.1–0.3% lower than the drying method. The detn. does not require more than 1.5 hrs. (C)

OLIVE OIL: ANALYSIS OF. G. B. Martinenghi. *Fette u. Seifen,* 1939, V. 46, P. 333–7 (through *Brit. Chem. Abs. B,* 1939, V. 58, P. 961); abs. in *J. T. I.,* Nov. 1939, P. A725.

The properties and characteristics of unrefined and refined, expressed and refined solvent-extracted olive oils are reviewed in relation to various methods for the detection of blending and adulteration. (C)

PHOTO-ELECTRIC COLORIMETER. F. Loewenberg. *Am. Dye. Rptr.,* Nov. 27, 1939, P. 706.

The Lumetron Photo-electric Colorimeter has been designed by Dr. F. Loewenberg, New York City, for the greatest possible flexibility and for obtaining results reproducible within the narrowest possible limits. The construction of the colorimeter allows the use of a great variety of sample holders and light filters, including monochromatic filters. As a result, the instrument covers a wide field of application, ranging from simple measurements of light transmission of liquids to colorimetric and turbidimetric chemical analysis and to abridged spectrophotometric determinations. Special provisions have been made for the accurate measurement of extremely dark and extremely transparent liquids. (C)

PHYSICAL AND CHEMICAL TEXTILE TESTING. John H. Skinkle. XVI, Part III. Microscopical Testing. Chap. 16, Identifications. Chap. 17, Determination of Quality, Damage, and Quantitative Analysis. *Am. Dye. Rptr.,* 1939, Aug. 21, P. 461–4; Sept. 18, P. 553–4, 571–2. (C)

PHYSICAL TESTING IN THE TEXTILE INDUSTRY. Erwin J. Saxl. *Am. Dye. Rptr.,* Oct. 16, 1939, P. 615–8.

Paper presented before R. I. Section, A. A. T. C. C., Feb. 1939. Illustrates and describes a series of textile testing instruments developed by the author. (C)

RAPID EXTRACTION FOR MILL CONTROL. Herbert C. Haller. *Am. Dye. Rptr.,* Oct. 30, 1939, P. 629–30.

Describes an apparatus that has the advantage of speed with reasonable accuracy. Admittedly less accurate than the Soxhlet method especially when extractable matter is low. (C)

SHRINKAGE OF WOOL FABRICS: TENTATIVE STANDARD METHOD FOR MEASUREMENT OF RESISTANCE TO. *J. T. I.,* Oct. 1939, P. S22–8.

This is "Tentative Textile Standard No. 1, 1939," authorized for publication under the "Textile Institute (Manchester, Eng.) Standardisation Scheme." It covers procedure for determination of shrinkage by soaking (relaxation shrinkage) and for determination of shrinkage by milling (felting shrinkage). (C)

SHRINKAGE: TESTING OF WOOL FABRICS FOR. *J. T. I.,* Oct. 1939, P. S29–40.

This paper is intended to amplify the instructions and to justify what may appear as arbitrary conditions laid down in Tentative Textile Standard

No. 1 of the Textile Institute Standardisation Scheme. This article and the accompanying tentative standard have been reprinted in one booklet under the title "Standardisation in Textiles." (C)

SPOT TESTING IN TEXTILE ANALYSIS. Erwin J. Saxl. *Am. Dye. Rptr.*, Dec. 25, 1939, P. 757–8.

Gives three references for details of this method of textile analysis, and describes a spot test for phenol, and one using rubeanic acid for indicating small traces of copper. (C)

STAPLE FIBRE: BEHAVIOR ON WASHING. E. Elöd and H. Haas-Wittmüss. *Mell. Textilber.*, 1939, V. 20, P. 571–5.

Considerable differences are observed in the behavior of the different staple fibre products but the loss in weight is always lowest in the pH region of 6 to 7 and rises rapidly in the region of pH 10 to 12. (C)

STAPLE FIBRE FABRIC: DAMAGE IN LAUNDERING. O. Uhl. *Mell. Textilber.*, 1939, V. 20, P. 511–3.

It is pointed out that determinations of degree of polymerization and wet strength provide means for determining the effects of washing processes on staple fibre fabrics and of distinguishing between chemical and mechanical damage. (C)

TEXTILE FIBRES AND YARNS: CONDITIONING AND TESTING. *Leipz. Monats. Text. Ind.*, 1939, V. 54, P. 188–94; abs. in *J. T. I.*, Nov. 1939, P. A720.

Details are given of the revised German tentative standard methods for the conditioning of textile fibres and yarns, the determination of commercial weights, and the determination of yarn counts, published in DIN DVM 3821, Entwurf 2. A chart for recording the results of tests on yarns is reproduced. (C)

VINYON'S PROPERTIES. *Text. Wld.*, July 1939, P. 54–5.

New synthetic fibre just patented has many potential uses in textile industry. (C)

VISCOSE IMPURITIES: DETERMINATION AND DETECTION OF. Ernst Kühnel. *Kunstseide u. Zellwolle*, 1939, V. 21, P. 369–74; abs. in *C. A.*, 1940, V. 34, Col. 260, 620. (C)

WARMTH TESTER. U. S. Testing Co. *Textile Age*, Jan. 1940, P. 75.

An apparatus for measuring the heat retaining qualities of textile materials, developed by the U. S. Testing Co., is briefly described. (C)

V. PURE SCIENCE, ECONOMICS AND MISC.

ANTI-TARNISH PAPER: INVESTIGATION OF. Herbert W. Rowe and Otto Kress. *Paper Trade J.*, Jan. 11, 1940, P. 33–6.

Of textile interest because designed to provide an impregnated paper resistant to silver tarnishing. The bibliography contains literature and patent references on textile tarnishproofing. (C)

CELLULOSE: CHANGES UNDERGONE BY—DURING HEATING. N. Kozhin. *Khlopchatobum. Prom.*, 1936, V. 6, No. 3, P. 29–30; *Chem. Zentr.*, 1938, V. I, P. 2096; abs. in *C. A.*, 1939, V. 33, Col. 8985.

Expts. were carried out on bleached cotton fabric. After heating 5 hrs. at 150° the fibres become yellow and partially sol. in cold 10% NaOH. Acids throw down a ppt. from the NaOH soln. The portion of this ppt. which is sol. in NaOH is designated as "pyrocellulose." Fibres contg. pyrocellulose show a much higher capillarity than other fibres. (C)

ELECTRO SOUND. Von Groterhell. *Umschau*, Dec. 25, 1938, V. 42, No. 52, P. 1196; abs. in *Eastman Kodak Abs. Bull.*, Sept. 1939, P. 473.

An apparatus is described which is similar to the electron microscope and which permits cathode rays to be focused to an exceedingly small image. This image can be moved over a certain area and the reflected or transmitted rays observed as usual. Because it is possible to control the movement of the electron beam with great precision, any variation of structure of the scanned surface may be located very accurately. (S)

LOVIBOND TINTOMETER ADAPTED BY MEANS OF THE ROTHAMSTED DEVICE TO MEASURE COLORS ON THE C. I. E. SYSTEM. R. K. Schofield. *J. Sci. Instr.*, March 1939, V. 16, P. 74–80; abs. in *Eastman Kodak Abs. Bull.*, Sept. 1939, P. 473.

The Rothamsted device is an obturator vane with which the observer, when matching a specimen by a combination of Lovibond glasses, can make the two surfaces he is viewing look equally bright. This device greatly reduces the number of combinations required for color matching. Conversion graphs give the C. I. E. co-ordinates for these combinations in Standard Illuminant B. The C. I. E. co-ordinates of matched colors are thereby obtained. (S)

NYLON GOES TO SEA. Dr. E. H. Killheffer. *The Du Pont Magazine*, Oct. 1939.

Describes the highly satisfactory results of practical tests of all-nylon lines in Gulf Stream fishing off the Florida Coast. An illustration shows the author standing beside a 60-lb. sailfish caught with a 24-lb. (between 9- and 12-thread) line. It was a highly exciting experience, but all research is to those who have hooked or landed a new basic fact. (C)

OXY- AND HYDRO-CELLULOSES: PROPERTIES. F. Müller. *Helv. Chim. Acta*, 1939, V. 22, P. 208–16, 217–24, 376–81; abs. in *J. T. I.*, July 1939, P. A480. (C)

pH: EXPRESSION OF—AS AN ARITHMETIC QUANTITY. Lewis B. Miller. *Paper Trade J.*, Sept. 21, 1939, P. 22–3.

The logarithmic method of expressing hydrogen ion concentration by means of the symbol pH may sometimes prove confusing. An arithmetic system of expression at times possesses advantages over the logarithmic method. The symbols A_H and A_{OH} are recommended for the terms Active Acidity and Active Alkalinity, respectively. The terms active acidity and active alkalinity, previously suggested and defined by other writers, are here defined strictly on the basis of hydrogen and hydroxyl ion concentra-

tions. A table of equivalent values in which active acidity and active alkalinity are expressed in both logarithmic terms and in familiar arithmetic terms, is presented. (C)

PHOTOCHEMICAL DECOMPOSITION OF THE CYSTINE IN WOOL. Henry A. Rutherford and Milton Harris. *Text. Rsch.*, Nov. 1939, P. 17–21; *N. B. S. J. Rsch.*, Nov. 1939, P. 597–601; *Am. Dye. Rptr.*, Nov. 13, 1939, P. 655–6, 678.

The work reported in the present paper is a continuation of earlier work on the photochemical decomposition of wool. The data confirm the hypothesis that the primary action of the radiation, which results in a change in the state of the sulfur and a corresponding lowering of the cystine content, is independent of the moisture in the system. The results indicate, however, that moisture plays an important role in the secondary process, namely that involving the evolution of hydrogen sulfide from the irradiated fibres. It is also shown that decomposition of the cystine, resulting from thermal reactions under the conditions of these experiments, is negligible. (C)

PHOTOMICROGRAPHY: BIRTH OF A TECHNIQUE. B. M. Belin. *Photo-Revue*, April 1, 1939, V. 51, No. 7, P. 105–06; abs. in *Eastman Kodak Abs. Bull.*, July 1939, P. 374.

A historical article, covering the period from Bonnani (1667) to Abbe (1875), reviews the development of the condenser and its use on microscopes for photomicrography. (S)

PROTEIN MOLECULES: PHYSICAL-CHEMICAL CHARACTERISTICS. E. J. Cohn. *Chem. Revs.*, 1939, V. 24, P. 203–32; abs. in *J. T. I.*, July 1939, P. A493. (C)

PROTEINS: ELECTROPHORESIS. L. G. Longsworth and D. A. MacInnes. *Chem. Revs.*, 1939, V. 24, P. 271–87; abs. in *J. T. I.*, July 1939, P. A494.

A discussion is presented of the principles underlying the Tiselius method of protein electrophoresis together with a description of the experimental procedure involved in the use of the method, including modifications introduced by the authors. The topics considered are: (1) the apparatus, (2) the optical principles involved in the observation of electrophoretic boundaries, (3) the effects of thermal convection, (4) some typical applications of the method and (5) boundary anomalies. A list of 18 references is added. (C)